

ELEVENTH ANNUAL REPORT

OF THE

NORTH DAKOTA

Agricultural Experiment Station

AGRICULTURAL COLLEGE, N. D.,

TO THE

GOVERNOR OF NORTH DAKOTA,

February 1, 1901.

BISMARCK, N. D.
TRIBUNE, STATE PRINTERS AND BINDERS
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STATION STAFF.

J. H. Worst, LL. D.....	Director
E. F. Ladd, B. S.....	Chemist
C. B. Waldron, B. S.....	Horticulturist
H. L. Bolley, M. S.....	Botanist
J. H. Shepperd, M. S. A.....	Agriculturist
L. R. Waldron, B. S.....	Assistant Botanist
A. M. Ten Eyck, M. S.....	Assistant Agriculturist
H. M. Ash	Foreman in Agricultural Department
C. D. Porter	Foreman in Horticultural Department
Herman Croft	Herdsman
J. Jessen	Assistant Herdsman
R. A. Shattuck	Secretary



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LETTER OF TRANSMITTAL.

Fargo, N. D., February 1, 1901.

To His Excellency Governor Frank White, Governor of the State
of North Dakota:

Sir: As required by act of congress, approved March 2, 1887 and section 13, chapter 160 of the laws of 1896 for North Dakota, I hereby submit the eleventh annual report of the North Dakota agricultural experiment station for the year ending February 1, 1901, together with a financial statement of receipts and disbursements as required by law, for the government fiscal year ending June 30, 1900.

Very respectfully yours,

W. H. ROBINSON,
President Board of Trustees.

REPORT.

To the Board of Trustees of the North Dakota Agricultural College and Experiment Station:

Gentlemen: I have the honor to submit to you the eleventh annual report of the North Dakota agricultural college and experimental station. The past season was marked by general and continuous drought during the spring and early summer months, followed by unusual precipitation during the later summer months and autumn. As a result the crops were more than usually sensitive to cultivation methods and systems of rotation. The experimental work was therefore greatly affected by the abnormal weather conditions but not the less interesting and instructive. The data collected during the year is very important.

The following bulletins were published during the year:

No. 43. A study of the root systems of cultivated plants grown as farm crops.

No. 44. (1.) Water hemlock poisoning.

(2.) Preserving eggs.

No. 45. Feeding trials with work horses.

1. Roughage.

(1.) Brome hay.

(2.) Timothy hay.

(3.) Oat straw.

2. Grain.

(1.) Oats.

(2.) Barley.

(3.) Malt.

(4.) Corn.

(5.) Wheat.

(6.) Bran and shorts.

No. 46. Preliminary list of the seed bearing plants of North Dakota.

On the morning of January 4, 1901 we had the misfortune to lose our large general purpose barn by fire. All of the contents except the horses and cattle, several vehicles and some minor implements were destroyed. The barn men lost all their personal effects, several of them losing quite heavily, in their generous efforts to save the property of the college and station and merit your commendation for the sacrifices they made.

Many valuable varieties of grain were burned which will prove a serious loss to the experiment station. The barn and contents were fully insured and satisfactory adjustments were made by the several insurance companies. The college received \$11,853.80 which will enable us to rebuild early in the spring. I would recommend the erection of two barns instead of one.

A stable 28x80 feet has been constructed for temporary shelter for the horses. A similar structure will be necessary for the cattle in the near future.

The station is under great obligations to Mr. James K. Kennedy for the use of his barn, situated on 11th Avenue North, where the stock was temporarily housed after the fire and where the cattle can be sheltered until spring.

Since my last report farmers' institutes were held at Lakota, Larimore, Milton, Edgeley, LaMoure, Monango, Pembina, Blanchard, Park River, Aneta, Langdon, Walhalla, Grafton, Neche, Hamilton, Mayville, Hope, Milton, Rolla, Bottineau, Foreman, Havana, Rolla, Devils Lake and Churchs Ferry. These institutes were conducted under the direction of Prof. E. E. Kaufman, assistant dairy and food commissioner, assisted by members of the station staff. This work was in addition to their regular duties as experimenters and teachers. A number of institutes are scheduled for the winter and spring months, but about thirty-five applications for institutes were rejected for want of time to conduct them, owing to the large enrollment of students for the special courses in agriculture.

The demand for farmers' institutes is now beyond our facilities to conduct them without a sufficient appropriation by the legislative assembly to organize a paid corps of institute conductors whose entire time can be devoted to such work during the winter months. The interest manifested by the farmers in such institutes and their evident helpfulness to farming communities fully warrants their being fostered by the state. Mr. T. A. Hoverstad of the Crookston, Minnesota station rendered valuable assistance at a number of institutes for which the station staff is under obligations. The station is also indebted to J. A. Power of Power, and Ernest G. Schollander of Montpelier, a student now in college, for assistance at several institutes.

The annual report of the experiment station contains much valuable information for farmers and should be widely distributed. Other agricultural states send out their station reports, containing from three to eight hundred pages each, by the thousand, to those interested in agriculture. Under our present system but a few dozen are available after sending copies to the departments at Washington, to station libraries and to station workers throughout the United States, as required by law. The report contains a resume of the year's work which does not find

its way into the bulletins, and but few farmers can obtain it until arrangements are made for its more liberal distribution. Provision should be made for the publication of several thousand copies for gratuitous distribution among the farmers of the state.

The department of agriculture has entered into a contract with the department of agriculture at Washington to co-operate in a series of experiments and will receive joint credit for the work accomplished.

I respectfully call your attention to the subjoined reports of the several members of the station staff.

J. H. WORST,
Director.

CHEMICAL DEPARTMENT.

To J. H. Worst, Director:

Sir: I submit my eleventh annual report for the department of chemistry for the year 1900.

The work of this department has included a wide range of subjects and a large share of the time of an assistant has been devoted to routine work made necessary for the demands of farmers for assistance in many lines, such as water examination, soil testing, testing formaldehyde, etc.

The work of the chemical department has been seriously handicapped for want of proper room to conduct lines of investigation that should be taken up or even in carrying forward the work we now have in hand.

When all lines of chemical work must be carried on in the same rooms and a large share of one's energies and time must be devoted to setting up and taking down apparatus that should have a fixed place, but little real advice can be made. Until this department can have laboratory facilities adequate for its demands but little can be accomplished, by the department of chemistry, of lasting benefit to the agriculture of the state. The department has, we believe been able to render direct benefit to the state in the matter of soil studies and in calling attention to proper methods for conserving soil fertility, that should be the means of largely improving the agriculture of the state. Again in demonstrating the cause for the loss of so much stock due to poisoning from eating water hemlock often found in "slough" hay. The department has benefited the farmers. One stockman reports the loss of fifty-two animals in a single winter, the

cause being unknown at the time, but he is now confident the loss came from this plant which was abundant in the hay and the properties of which he did not know at the time.

During the past year as in previous years a large number of animals were poisoned by eating this plant. Bulletin No. 44 contains a description of the plant and its properties together with other information.

Since 1891 sugar beet experiments have been continued and this investigation has been carried out by this department until it is well demonstrated that North Dakota is favorably situated and that the south part of the state, at least, comes well within the sugar producing belt of the union. The result of these co-operative experiments has attracted the attention of capitalists, and it is reported that a beet sugar factory is to be built at Oakes, one of the most favorably located points for such an industry.

Judging from our examination of the beets grown in the region about Winona, it should be a favorable section. The location on the banks of the Missouri affording such cheap and excellent means of transportation for coal, beets and even the manufactured sugar would seem to warrant further experiments in this region. During 1901 it is proposed to make Winona and Jamestown the two focal points, about which special sugar beet experiments will be undertaken.

It is proposed also during the present year to plan and execute experiments to determine the fitness of North Dakota soil and climate for producing pears, beans, corn and tomatoes suitable for canning and to aid in establishing such an industry in what seems to be well adapted localities in the state.

Much of the analytical work for the past year has been carried out by my assistant, Mr. Hugh McGuigan, who has very carefully and well performed the duties assigned him.

During the past year I have been present and spoken at seven farmers' institutes in different parts of the state, and at the grain growers' convention at Fargo. Some time has also been devoted to nature study work in preparing an outline for the rural schools of the state. The course begins with simple observation work for the youngest pupils and leads up to the principles of agriculture to be taught during the last two years of the common school course. It is believed this educational work will be of benefit to the station, as the pupils will have some knowledge of the science of agriculture, hence will derive more benefit from the bulletins sent from the station.

WHEAT STUDIES.

It is a notable fact in the analysis of wheats from year to year that there has been a gradual falling off in the per cent of proteids and gluten contained in our wheats, grown in North Dakota.

A few determinations of the per cent of nitrogen in wheats from individual heads have been made, also examinations have been made of the heads from individual stools. Our object being to determine to what extent there might be variation in nitrogen content, and whether there was uniformity for heads of the same stool.

Both fife and blue stem wheats were analyzed and the results from each head and for the individual heads in each stool are given below for a few samples under examination.

1.....	2.24	14.00
2.....	2.52	15.75
3.....	2.53	15.81
4.....	2.20	13.75
Average	2.372	14.82
6.....	2.45	15.31
7.....	2.81	17.56
9.....	2.56	16.00
Average..	2.606	16.29
11..	2.92	18.25
12.....	2.43	15.50
15.....	2.66	16.62
Average	26.87	16.79
21.....	2.17	13.56
22.....	2.28	14.25
23.....	2.44	15.25
24.....	2.56	16.00
Average	2.362	14.76
43.....	2.92	18.25
44.....	2.55	15.94
Average	2.735	17.09

74.....	2.34	14.62
77.....	2.15	13.44
82.....	2.36	14.75
83.....	2.57	16.17

Average	2.355	14.74
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An inspection of the preceding table shows individual heads to range in proteid content from 13.56 per cent to 18.25 per cent, a range of 4.69 per cent, while the mean for the stools have varied from 14.74 per cent to 17.09 per cent.

About one-half the seeds in each head was used for analysis and the balance of each head has been saved for planting in order to determine whether seed with a high proteid content will produce seed of like quality and whether those of low proteid content will propagate like the parent seeds.

The work in seed selection of wheat heretofore, so far as I am aware, has been along the line of selecting the seed from general appearance and growth of the plants. It was our thought that possibly by selecting seed from heads having a high gluten content some improvement could be made along these lines, and result in developing a wheat with a uniformly higher gluten content. Corn is also being examined in a similar manner and the results of the outcome of these experiments with wheat and corn are awaited with considerable interest, for judging from experiments in other lines we feel justified in expecting that considerable improvement may be made following out this line of work.

SUMMARIES OF TEMPERATURE, RAINFALL AND SUNSHINE.

The past year has been very exceptional and it may almost properly be said to be both the driest and wettest year during the ten years of our records at Fargo. It was the dryest the first half of the year when grains needed moisture to produce a crop, and the wettest during the last half of the year, giving the largest rainfall for any year during the life of this station.

The following table gives the maxima, minima and mean monthly temperature for the year 1900:

	Maximas	Minimas	Means	Rainfall in inches
January.....	52	-25	14.1	0.45
February.....	35	-30	-1.2	0.54
March.....	55	-15	19.6	1.23
April.....	87	15	19.6	1.82
May.....	97	24	50.0	0.81
June.....	98	31	66.0	2.11
July.....	101	40	67.1	3.91
August.....	93	42	72.8	8.28
September.....	90	26	56.5	3.27
October.....	31	22	49.7	2.80
November.....	59	-15	20.0	0.20
December.....	38	-17	14.1	0.12
				25.54

MONTHLY RECORD OF SUNSHINE.

The hours of actual sunshine given in the following table is the amount recorded by means of a Friez photographic sunshine recorder, but contains no correction for early morning and evening sunshine unrecorded by the instrument.

To these records should be added about 12 to 15 per cent for the unrecorded sunlight, while the rays of light are not strong enough to produce a record.

SUNSHINE RECORD

1899						1900				
	Total hours possible	Total hours recorded	Daily mean hours possible	Daily mean hours recorded	Percentage of sunshine	Total hours possible	Total hours recorded	Daily mean hours possible	Daily mean hours recorded	Percentage of sunshine
January.....	279.0	87.3	9.0	3.0	31.3	279.0	98.5	9.0	3.4	37.8
February.....	273.1	141.6	9.8	5.1	51.9	273.1	136.6	9.8	4.9	50.0
March.....	369.0	205.9	11.9	3.6	55.5	369.0	174.9	11.9	5.6	44.9
April.....	394.3	243.0	13.1	8.1	61.6	394.3	259.6	13.1	8.7	65.8
May.....	466.3	182.5	15.	5.9	39.1	466.3	319.6	15.	10.3	68.2
June.....	474.9	250.	15.8	8.3	52.2	474.9	259.6	15.8	8.7	55.1
July.....	480.2	306.25	15.5	9.88	63.7	480.2	269.6	15.5	8.7	56.1
August.....	441.8	189.0	14.3	6.4	42.8	441.8	161.9	14.3	5.2	36.4
September.....	378.3	222.6	12.6	7.4	58.7	378.3	148.4	12.6	4.9	38.9
October.....	336.6	100.4	10.6	3.2	29.4	337.6	104.1	10.6	3.4	31.2
November.....	281.6	110.7	9.4	3.7	39.3	281.6	103.1	9.4	3.4	36.6
December.....	267.1	127.6	8.6	4.1	47.7	267.1	80.6	8.6	2.6	30.2
Total and means.....	4443.2	2168.85	12.1	5.97	48.8	4443.2	2116.5	12.1	5.7	47.1

We present below the total rainfall of years beginning with 1892, as recorded at this station.

	1892	1893	1894	1895	1896	1897	1898	1899	1900
Total rainfall..	20.73	16.17	18.72	16.85	20.36	22.30	16.20	21.21	25.54

This gives the mean annual rainfall of 19.78 inches for the past ten years and an excess of 5.76 inches for the past year above the average for the ten years.

CALCULATED AND RECORDED DAILY TEMPERATURES.

The question has been frequently raised as to whether the mean temperature for a day as calculated for the reading of the maximum and minimum thermometers was a correct record for this climate. Following we give both the calculated temperature and the daily average as actually recorded by means of a Draper's self recording instrument and the records made from each hour record for the full day of twenty-four hours.

Agri.—2

	April		May		June		July		August		September	
	Recorded	Calculated	Recorded	Calculated	Recorded	Calculated	Recorded	Calculated	Recorded	Calculated	Recorded	Calculated
1	....	9.5	41.1	40.	53.9	60.5	75.0	65.5	96.9	64.	70.8	73.
2	....	6.0	46.4	45.	61.4	64.0	62.7	64.5	67.9	63.	63.0	61.5
3	....	14.5	45.7	45.	65.9	67.0	67.4	63.5	67.3	67.0	58.2	55.5
4	27.0	22.5	30.7	40.5	61.9	65.5	67.1	63.0	64.1	63.0	71.1	66.5
5	31.8	27.5	50.5	53.5	59.6	61.0	69.7	70.0	66.3	63.5	60.3	58.0
6	28.9	27.5	59.8	58.	61.2	62.0	68.8	65.0	66.8	70.0	65.2	66.0
7	36.3	33.0	....	60.5	62.8	55.5	69.6	65.0	71.3	70.5	59.6	57.5
8	33.3	39.5	59.3	57.0	50.1	53.0	58.8	63.5	71.0	67.5	59.9	57.5
9	41.3	41.0	57.5	65.	63.1	58.5	71.5	72.0	69.9	70.5	66.8	64.0
10	45.0	49.0	65.6	71.5	64.9	64.0	71.2	71.5	69.6	72.0	60.6	61.5
11	47.0	46.0	56.5	63.5	67.2	67.5	72.9	71.0	65.7	69.0	66.0	65.5
12	54.1	54.0	68.4	44.	63.8	67.5	72.4	64.5	54.9	52.5	58.0	53.5
13	50.4	51.5	47.9	38.	65.3	60.5	69.1	69.5	56.1	52.5	53.5	47.0
14	39.7	40.0	41.0	49.5	55.9	57.5	71.8	75.0	68.4	65.5	59.9	57.5
15	32.9	39.0	46.4	45.5	56.8	53.5	41.6	66.5	74.4	73.5	62.1	58.0
16	....	45.0	44.9	42.0	64.3	62.5	65.4	64.5	76.1	76.0	55.3	56.0
17	51.6	51.0	42.8	45.	70.6	70.5	70.3	64.0	73.3	74.5	52.7	51.5
18	42.1	35.5	47.4	45.	70.1	68.5	74.7	73.5	69.3	70.0	54.4	53.0
19	38.7	38.5	48.9	54.5	68.1	69.5	77.0	77.5	69.3	68.5	52.4	53.5
20	43.5	39.5	59.1	55.5	63.1	59.0	71.2	67.5	70.0	72.5	55.3	56.5
21	37.6	40.0	61.8	57.0	50.6	69.0	72.2	70.5	67.0	65.0	53.5	49.5
22	34.2	49.5	58.8	51.5	60.7	56.5	81.6	79.5	74.2	75.0	53.0	49.0
23	56.1	55.0	55.8	51.5	60.7	62.5	73.2	77.0	64.4	67.0	57.3	53.5
24	59.8	58.	57.1	58.5	64.3	61.5	70.9	70.0	65.7	65.0	52.2	57.5
25	51.3	55.	58.6	62.5	68.2	65.5	70.3	70.0	66.8	69.0	48.9	46.0
26	65.8	61.	65.4	67.5	70.6	70.0	66.6	69.0	66.8	73.5	52.5	52.5
27	60.4	62.	62.2	61.	66.7	69.5	70.9	70.0	63.5	64.0	54.4	58.5
28	45.5	48.5	60.2	47.	66.7	65.0	56.8	66.0	76.1	79.5	35.3	35.5
29	40.8	41.5	52.5	60.	69.6	73.0	58.8	56.5	66.4	64.5	41.9	32.
30	49.4	47.	30.7	58.5	73.6	75.0	66.1	63.0	69.0	62.5	38.2	42.5
31	....	....	58.2	59.	....	....	72.7	65.0	60.4	59.0	....	....
Mean..	42.3	41.1	52.2	54.0	63.8	63.8	68.6	68.4	67.7	67.3	55.1	52.2

An inspection of the above results shows but little difference between the calculated and the recorded temperature for the several months.

MEAN HOURLY TEMPERATURE BY MONTHS.

In the following table are given the mean average hourly temperature for each month from April to October as compiled from the records made by the self-recording thermometer for 1899.

A. M.	April	May	June	July	August	Sept.
1 o'clock	40.18	46.12	59.11	59.5	60.11	52.15
2 "	45.23	45.25	60.26	60.23	65.30	50.20
3 "	40.65	42.15	57.26	59.31	65.50	49.15
4 "	39.14	44.37	56.65	59.56	64.18	49.60
5 "	38.10	43.00	55.32	60.31	60.25	51.75
6 "	49.20	43.14	56.13	62.56	61.27	48.21
7 "	38.10	45.00	59.52	63.13	66.23	49.18
8 "	42.17	48.29	65.26	63.93	65.11	49.19
9 "	44.26	51.32	64.31	69.17	67.14	53.10
10 "	42.15	51.15	66.11	72.12	70.31	58.36
11 "	46.12	51.17	68.15	73.11	71.23	61.15
12 "	44.30	53.26	70.80	77.00	72.11	63.90
P. M.						
1 o'clock	47.11	58.72	71.80	77.10	73.11	66.16
2 "	48.38	59.00	71.60	78.10	75.31	68.20
3 "	45.24	59.13	71.26	79.20	74.18	68.17
4 "	53.13	57.27	71.48	79.52	74.25	66.44
5 "	49.68	56.10	70.13	78.22	74.77	67.12
6 "	48.12	57.10	69.14	76.3	72.12	66.17
7 "	47.21	57.15	67.32	73.11	67.17	62.16
8 "	35.10	54.00	62.31	71.43	68.42	59.00
9 "	43.11	51.75	60.32	70.14	69.15	56.40
10 "	42.15	46.21	62.50	65.15	65.37	54.21
11 "	41.13	48.16	59.50	60.12	62.18	56.93
12 "	40.10	45.11	58.31	62.20	61.25	52.14
Mean.....	42.26	52.21	63.76	68.59	67.70	57.12

Much work was required in compiling the temperature records for 1899 as given above, and it is believed the data will be helpful in understanding some phases of work now in progress at the station in plant growth, in relation to soil fertility and the available moisture.

SUGAR BEET EXPERIMENTS FOR 1900.

The sugar beet experiments in North Dakota for 1900 were almost a complete failure when compared with the results for previous years. When we consider the unusual season and the fact that the wheat and hay crop were the poorest in the history of the state we do not feel that the results do more than point out that an occasional poor year will occur.

Seeds were sent out to 325 farmers in all parts of the state. The season was so dry in the early summer that only forty-two farmers grew any beets whatever. In many instances farmers report that the ground was so dry that seed planted in May failed to germinate until the July rains came. The total snow and rainfall from January to July at Fargo was 6.96 inches. As the ground received but little moisture the preceding fall, there was not enough soil moisture to insure plant growth except when the land had been kept cultivated to conserve the soil moisture. In very few instances was this done with the small plots of ground where beets were to be grown. In early July beets that had started and withstood the drought began to make very rapid growth for during the four months, July, August, September and October the total rainfall was 18.26 inches, or only about one and one-half inches less than the average annual rainfall for Fargo for the previous nine years. The following table shows the rainfall and the per cent of cloudy weather for the several months.

	Inches	Per cent cloudy during day
April	1.82	36
May	.81	32
June	2.11	45
July	3.91	44
August	8.28	64
September	3.27	61
October	2.80	69

The last three months show a condition very unfavorable for the sugar formation and the results are, as might be expected, very low and not one of the forty-nine samples of beets sent in could be considered as mature. In a few instances the warm wet weather started a second growth with new top formation and lowered the sugar present as shown by earlier analysis. This is well shown in case of numbers 58 and 244.

ANALYSIS OF BEETS FOR 1900.

Name	Post Office	Date Planted	Date Harvested	Average Weight	Per Cent Sucrose	Coefficient of Purity
1 M. J. Thompson.....	Calehutt.....	May 5.....	Sept. 21.....	1 lb. 3 oz.....	9.62.....	69
4 F. R. Rosenans.....	".....	May 5.....	Sept. 26.....	2 lb. 1 oz.....	9.46.....	68
10 M. C. Serpensing.....	Larimore.....	May 5.....	Oct. 28.....	1 lb. 9 oz.....	11.60.....	68
26 N. N. Fralick.....	".....	May 10.....	Sept. 29.....	2 lb. 10 oz.....	8.62.....	67
26 N. N. Fralick.....	Wahalla.....	April 15.....	Oct. 16.....	2 lb. 3 oz.....	9.48.....	71
17 John J. Esstad.....	".....	April 15.....	Sept. 19.....	1 lb. 9 oz.....	8.14.....	64
17 John J. Esstad.....	Hatton.....	May 25.....	Oct. 18.....	1 lb. 10 oz.....	14.46.....	77
14 Emiel Wiese.....	".....	May 25.....	Sept. 25.....	1 lb. 0 oz.....	10.58.....	74
18 John Ramsdell.....	Eldridge.....	May.....	Oct. 13.....	1 lb. 13 oz.....	11.36.....	69
31 W. O. Wilson.....	Kenmare.....	May.....	Oct. 7.....	1 lb. 7 oz.....	10.72.....	68
41 W. J. Beaver.....	Dunseith.....	May.....	Oct. 20.....	1 lb. 4 oz.....	9.78.....	63
42 Thomas Hull.....	Monango.....	June 15.....	Sept. 18.....	5 lb. 12 oz.....	3.60.....	
45 Stephen Donnelly.....	Fairmount.....	May 5.....	Sept. 20.....	2 lb. 0 oz.....	6.44.....	
48 C. W. Sherwin.....	Grafton.....	May 10.....	Oct. 2.....	1 lb. 10 oz.....	7.98.....	
58 James Greenwood.....	Wimbledon.....	May 10.....	Sept. 19.....	0 lb. 6 oz.....	8.94.....	55
58 James Greenwood.....	".....	May 10.....	Oct. 11.....	0 lb. 13 oz.....	12.16.....	80
67 Frank Duray.....	McLean.....	May 8.....	Oct. 8.....	1 lb. 2 oz.....	13.70.....	46
74 S. S. Keim.....	".....	May 8.....	Oct. 8.....	1 lb. 4 oz.....	11.80.....	70
77 Henry Pruth.....	Warsaw.....	May 15.....	Oct. 2.....	2 lb. 3 oz.....	5.92.....	75
80 John N. Knackstedt.....	Kenmare.....	May 20.....	Oct. 8.....	1 lb. 5 oz.....	10.56.....	74
83 Fred Jessel.....	Stillwell.....	May 20.....	Sept. 20.....	1 lb. 3 oz.....	8.68.....	80
84 Wm. Perrin.....	Omamee.....	May 10.....	Sept. 29.....	1 lb. 9 oz.....	9.30.....	66
84 Wm. Perrin.....	".....	May 2.....	Oct. 16.....	1 lb. 13 oz.....	12.56.....	78
84 Wm. Perrin.....	McKenzie.....	May 2.....	Sept. 18.....	0 lb. 9 oz.....	10.24.....	69
84 Wm. Perrin.....	".....	May 15.....	Oct. 19.....	1 lb. 0 oz.....	10.48.....	68
84 Wm. Perrin.....	Storlie.....	May 15.....	Sept. 29.....	1 lb. 15 oz.....	9.03.....	63
84 Wm. Perrin.....	".....	May 15.....	Oct. 7.....	1 lb. 8 oz.....	13.12.....	67
84 Wm. Perrin.....	".....	May 15.....	Oct. 28.....	2 lb. 4 oz.....	13.44.....	72
95 F. A. Hughes.....	Maza.....	June 1.....	Oct. 3.....	1 lb. 9 oz.....	6.32.....	56
99 Adam Bennett.....	Scodia.....	June 10.....	Oct. 3.....	1 lb. 0 oz.....	14.62.....	76
103 Jas. Mackie.....	Wyndmere.....	May 12.....	Nov. 9.....	1 lb. 12 oz.....	7.06.....	62
111 T. J. McCully.....	".....	May 12.....	Oct. 10.....	1 lb. 10 oz.....	8.22.....	62
112 Geo. T. Jager.....	Lisbon.....	May 10.....	Oct. 20.....	3 lb. 12 oz.....	10.92.....	71
261 David Finnie.....	Grinnell.....	May 24.....	Sept. 28.....	2 lb. 5 oz.....	10.02.....	68
261 David Finnie.....	Gilbert.....	May 20.....	Sept. 26.....	0 lb. 5 oz.....	11.68.....	73
309 L. A. Beaudoin.....	Emerado.....	May 16.....	Sept. 21.....	0 lb. 14 oz.....	9.44.....	70
309 L. A. Beaudoin.....	".....	May 16.....	Oct. 14.....	1 lb. 14 oz.....	12.04.....	74
309 L. A. Beaudoin.....	St. John.....	May 14.....	Sept. 25.....	0 lb. 15 oz.....	10.46.....	70
309 L. A. Beaudoin.....	".....	May 14.....	Oct. 16.....	1 lb. 3 oz.....	11.22.....	67

ANALYSIS OF BEETS FOR 1900.—Continued.

Name	Post Office	Date Planted	Date Harvested	Average Weight	Per Cent Sucrose	Coefficient of Purity
274 C. Nordvie.....	Georgetown	May 14	Oct. 2	2 lb. 3 oz.	8.02	63
295 Bernard Campbell.....	Buchanan	May 22	Oct. 2	2 lb. 2 oz.	9.56	72
295 ".....	"	May 22	Oct. 29	1 lb. 14 oz.	9.24	70
244 C. B. Boyie.....	Jamestown	May 22	Oct. 1	1 lb. 8 oz.	9.28	69
244 ".....	"	Apr. 27	Oct. 26	1 lb. 15 oz.	17.12	64
206 Wm. Watt.....	Leonard	Apr. 27	Sept. 23	1 lb. 7 oz.	12.50	73
306 ".....	"	May 10	Nov. 5	2 lb. 0 oz.	12.98	76
216 J. S. Kemp.....	Galesburg	May 10	Oct. 15	2 lb. 9 oz.	11.90	73
Judson Harrington.....	Jamestown	June 10	Oct. 20	1 lb. 9 oz.	11.66	71
Peter Wickstrom.....	Lisbon	May 12	Sept. 24	2 lb. 2 oz.	4.66	50
227 Joseph Jasper.....	Woodhull	May 12	Oct. 20	3 lb. 3 oz.	8.66	65
247 ".....	"	May 10	Sept. 25	2 lb. 2 oz.	5.66	48
264 K. J. Veum.....	"	May 10	Oct. 19	1 lb. 8 oz.	9.18	64
265 Geo. Wesley.....	Hoople	May 15	Sept. 27	1 lb. 1 oz.	10.28	72
270 Fisher.....	Fisher	May 20	Oct. 20	1 lb. 2 oz.	10.34	69
270 L. G. Wells.....	Lisbon	May 10	Sept. 29	1 lb. 4 oz.	10.37	71
270 ".....	"	May 10	Oct. 12	1 lb. 4 oz.	8.82	71
270 ".....	"	Nov. 1	Nov. 1	2 lb. 4 oz.	9.34	72

As in previous years the beet seed was furnished by the department of agriculture at Washington and the franking privilege for sending out the seed and for bringing in the beets was granted by the secretary of agriculture, thus making it possible for us to continue this line of work in the state.

Five varieties of beet seed were sent out and the tabulated results for the few samples of each variety sent in are as follows:

	No sample	Sucrose per cent.	Coefficient of purity
White Improved Vilmorin	26	9.80	69
Zehringen	6	9.53	64
Leicht's Kleinwanzlebener	3	10.87	71
Drippe Bros.....	5	9.22	67
Russian	8	9.76	68

The average for the forty-nine samples analyzed was:

Per cent sucrose	9.81
Coefficient of Purity	65

The beets well cared for continued to form sugar quite rapidly as shown in case of number 26. Beets sampled September 19 gave 8.14 per cent of sugar and from the same plot those harvested October 18 or one month later contained 14.46 per cent. Number 84 for the three dates, September 29, October 7 and 28 gave the following per cents, 9.03, 13.12 and 13.44. An inspection of the tables will show the same general improvement, but the unfavorable season prevented maturity of the beets.

The repeated experiments of this station has demonstrated that North Dakota comes properly in the sugar beet belt and already capital has been attracted to the state for developing the industry. It is proposed to continue our sugar beet experiments for one year more in various parts of the state. After which it is proposed to study specific problems that will prove helpful to the farmers and manufacturers, should the industry become established in the state.

COMMERCIAL FERTILIZERS.

The first request for fertilizer analysis was made during the past year. Three samples were sent in by Mr. E. M. Upson of Cummings. Samples Nos. 2 and 3 were without name, while the first sample was the "Old Homestead" made in Detroit, Michigan. We find them to contain as follows:

	"Old Homestead"	No. 2	No. 3
Moisture.....	13.34	7.41	9.23
Total Potash, K_2O	2.11	0.56	0.28
Total Phosphoric and P_2O_5	59.24	13.35	10.68
Total Nitrogen.....	2.19	3.02	2.21

Under proper methods of cultivation and crop rotation with a soil containing such quantities of phosphorus acid, potash and

nitrogen as is found in the valley soils, there should be no need for these fertilizers. It would seem from experiments already recorded that an equal amount of money expended in conserving soil moisture, in better methods of cultivation and in maintaining a high per cent of humus in the soil would give better returns than is received from applying commercial fertilizers.

CLAYS AND CEMENTS.

During the past year several analyses of clays and other mineral deposits have been made and a few of these may be of value.

Two samples from the Pembina mountains sent in by B. G. Skulason of Grand Forks showed the following results:

	"A"	"B"
Silica Si O_2	12.72	25.43
Alumina $\text{Al}_2 \text{O}_3$	5.27	10.72
Iron Oxide $\text{Fe}_2 \text{O}_3$	2.51	3.60
Lime Ca O	40.72	28.39
Magnesia Mg O	1.62	1.23
Sulphuric Acid $\text{S}_2 \text{O}_3$	3.15	3.90
Alkalies.....	Trace	Trace
Volatile matter.....	34.64	26.16
	100.63	99.43

The sample "A" might prove suitable as the bases for a Portland cement if found in sufficient quantity.

Sample of material No. 1 was sent from Medora by J. W. Foley. Sample No. 2 was sent in by A. M. Anderson taken from a large deposit about seven miles southwest of Northwood, while sample No. 3 sent by the same party was reported as taken from the Babcock mines in the Pembina mountains:

	1	2	3
Silica Si O_2	42.23	40.15	26.97
Alumina $\text{Al}_2 \text{O}_3$	39.29	14.68	14.57
Iron $\text{Fe}_2 \text{O}_3$	3.80	5.20	4.25
Lime Ca O	1.88	15.76	23.45
Magnesia Mg O	0.61	0.94	0.60
Sulphuric Acid S O_3	2.12	2.03	3.99
Alkalies.....	2.15	1.84	0.59
Volatile matter.....	8.86	18.51	26.51
	100.93	99.11	100.93

From the Pembina mountains near Walhalla several samples of clays were examined showing a content of lime CaO ranging

from 34.95 per cent to 39.12 per cent, the layer being about 10 feet in thickness under a fifteen foot drift deposit. Near the upper portion of the deposit was a layer designated as iron bearing material.

The following shows the analyses of two of the samples from these deposits; one the iron bearing and the other the clay.

	"Clay"	Iron Deposit
Silicia Si O_2	18.47	33.49
Iron $\text{Fe}_2 \text{ O}_3$	7.27	4.10
Alumina $\text{Al}_2 \text{ O}_3$.....	.....	12.90
Lime Ca O	39.12	10.25
Magnesia Mg O	0.10	0.41
Sulphuric Acid S O_3	Trace	15.22
Alkalies.....	Trace	0.61
Volatile matter.....	34.37	22.23
	99.13	99.21

The first, it is thought, would be suitable for manufacturing cement, while the deposit designated as "iron deposit" might serve as the bases for a mineral paint.

Four samples of clays were sent in from Gardar, taken in a ravine, between 300 and 400 feet deep. Sample No. 1 taken about thirty feet from the bottom. A thin layer, No. 2, overlying No. 1 about twenty feet thick. No. 3 samples from a 6-inch layer overlying No. 2. No. 4 a 4 to 6-inch layer of dark material just above the others:

	Samples Numbers.			
	1	2	3	4
Silica Si O_2	52.22	58.88	58.90	71.10
Alumina $\text{Al}_2 \text{ O}_3$	18.26	15.40	22.97	12.88
Iron $\text{Fe}_2 \text{ O}_3$	8.70	5.60	1.12	2.62
Alkalies.....	2.40	2.40	0.66	1.26
Lime Ca O	trace	trace	trace	trace
Magnesia Mg O	trace	trace	trace	trace
Sulphuric Acid S O_3	30.52	0.68	0.50	0.29
Volatile matter.....	18.78	17.66	15.62	12.95
	100.88	100.62	99.77	101.10

Sample No. 3 above is not so very different from some analyses of the Stourbridge clays of England.

A sample of clay No. 1 in the following table was from a deposit near Langdon sent in by James Trennum.

Sample No. 2 was sent in from Lisbon by J. L. Brown.

Sample No. 3 taken from a bluff near Hebron which forms a 20 foot layer with three feet of overlying yellowish clay.

The results are shown in the following:

	Sample Numbered		
	1	2	3
Silica Si O_2	70.00	16.35	79.55
Alumina $\text{Al}_2 \text{O}_3$	17.19	6.12	14.26
Potash $\text{K}_2 \text{O}$	trace	trace	0.61
Soda $\text{Na}_2 \text{O}$	trace	trace	trace
Lime Ca O	0.90	24.30	trace
Magnesia Mg O	0.85	0.48	trace
Iron $\text{Fe}_2 \text{O}_3$	3.47	1.68	0.84
Volatile matter.....	5.00	35.79	4.54
Sulphuric acid S O_3	3.07	15.92	trace
	100.48	100.64	99.80

Sample No. 3 above is very similar in composition to some of the clays used so extensively as fire clay in the New Jersey industries.

Sample No. 1 from Langdon is of a similar kind but contains more iron and in addition sulfates.

LIME ROCK.

Deposits of lime rock suitable for burning for lime, so far as I am aware are not found in the state. Frequently specimens, mostly boulders or drift rock, are sent in for analyses. The following, one from Oakes in the south part of the state, and the other from the Pembina mountains in the north part of the state, shows about the average composition for these rocks:

	Oakes	Pembina Mountain
Silica Si O_2	trace	19.70
Lime Carbonate Ca CO_3	52.17	75.32
Magnesia Carbonate Mg CO_3	46.10	4.98
	98.27	100.00

SOIL INVESTIGATIONS.

The work in soil analysis and soil investigation regarding available plant food and soil moisture in relation to the organic matter and humus has been continued during the year. Much

data in regard to nitrates and nitrites are now ready for publication as a part of a forthcoming bulletin. Some studies of composted manures have furnished interesting data to be used in the same connection.

BROME GRASS.

During the past summer Adele Shepperd conducted an experiment to determine the relative yield and comparative value of timothy and Brome grass for hay and for pasturage. The season emphasized the value of brome grass in dry seasons or regions of low rainfall under conditions of soil and climate such as exist at Fargo. The full results will be published as a part of a forthcoming bulletin. In the experiment the field work was looked after by Professor Shepperd.

ASSISTANCE AND NEEDS.

During the past year Mr. Hugh McGuigan has been the assistant in the station laboratory and much of the analytical work has been done by him in a most satisfactory manner. The great need of this department at the present time is more space and rooms adapted to conducting research work, and I trust this condition may be remedied during the present year. We shall then be able to undertake other lines of work that should give results helpful in developing the agriculture and manufacturing industries of the state.

Respectfully submitted,

E. F. LADD.

Chemist.

DEPARTMENT OF BOTANY.

To Director J. H. Worst:

Sir: The lines of work in this department have been chiefly concerned with studies upon wheat, potatoes, flax, weeds and the native plants of the state. In general the studies are continuations of work undertaken in previous years.

WORK WITH WHEAT IN 1900.

Selection of wheat from the industrial head: Continuing the work of 1899 and of previous years and using the heads which were saved from 1899, plantings were made from twenty-one different lines of pedigrees representing forty-two individual heads. These heads were the best heads which could be selected from the crop as grown in 1899, one good head being selected from the best stool which grew from the largest grain found in the head which was grown in 1898, and one from the best stool which was grown in 1899 from the smallest grain selected from the head which was grown in 1898. The grains were planted in soil of good, even quality which had not received fertilizer for a number of years, in beds just large enough to allow six plants to grow in a row across the bed. From the selected heads there were taken six of the largest No. 1 hard grains and six of the smallest grains that could be selected, which yet remained perfect in form. The plants having been pulled in 1899, and cured in the laboratory were good and dry, hence all mature grains showed good color and form and were in good viable condition. It is easy under such conditions to select from a good mature head six large grains and six small ones which are perfect in form but very different in size. This year the large grains selected were almost always over twice the weight of the small ones selected. Each set of six grains was planted to an equal depth in a well prepared bed side by side, the rows being a foot apart, and the grains four inches apart, in the row. All were planted about one and one-half inches deep. At harvest time, July 25th, each stool was pulled, as in previous years, the roots dusted and the grain allowed to thoroughly ripen and cure in the straw as it stood in a well lighted airy room. September 10th records were taken upon the number of stools harvested for each planting, the number of straws, the total weight of stools, grain and straw, and the total length of the best straw in each case. Some of the

samples were photographed for records, and previous to planting in 1901 the total number of spikelets and grains of each selected head will be recorded, together with the total weight of the grains in each head. Though the details of this sort of experimental work accumulate very rapidly we hope to continue the experiment for a number of years, recording the data gained. There are already many pages of these records which will need to be compiled in a separate publication to give an idea of the results attained. A number of years records carefully kept will, we believe, allow one to draw a number of very definite conclusions regarding the proper methods of selecting grain with reference to the improvement of a variety. The details of the experiment are too extended for publication in this report. Suffice it to say that it is quite surprising how important the matter of pedigree or strain shows itself to be in regard to this important question. Though the year was very unfavorable for the growth of cereals, we succeeded in producing from these selected grains quite a perfect crop. During no time of the growing season was one able to distinguish between the growth from the large seed and that from the small seed from the same head. It is very noticeable that there was differences in the growth from the seeds from different stools, even in this close line of selection, which has been followed for three seasons, starting originally with what purported to be pure varieties of Scotch Fife and Blue Stem.

The actual record of all the different features of growth will probably show an advantage in favor of the large seed as against the small from the same head, but the statement which I think I am safe in making from a general survey of the work for three years, is that the quality of the individual grain as to viability is of very much more importance to the general farmer than the consideration of size; that is, it would be preferable to take a small grain of perfect quality rather than a much larger one from the same head, if slightly injured.

The following rough summaries upon some of the points of comparison will perhaps indicate about the variations which may be expected throughout the different comparisons which may be made between the small and the large seeds from the same head.

Length of straw produced: Out of thirty-four stools the number of times the best length of straw was in favor of the large grain was fifteen. The number of times the best length of straw was in favor of the small grain was ten, and the number of times in which the best length from the small grain was equal to the best length from the large grain was nine. This shows a margin of five times in which the greatest length was in favor of the large seed.

Total weight of straw and grain: The number of pairs considered was eighteen.

The number of times which the total weight from the large grain exceeded the total weight of product from the small grain was eleven.

The number of times which the total weight of the products from the small grains exceeded the total weight of the products from the large grains was seven.

The total weight, in grams, of straw and grain from eighteen rows from big grains was 1,417, there being 102 stools.

The total weight, in grams, of the product from eighteen rows or 102 stools from the small grains was 1,328 grams.

These points of comparison all show a slight advantage in favor of the product from the large seed, leading to the conclusion that even though not noticeable in the field as the crop is growing, the advantage is nevertheless in favor of the big seed. This would indicate that even though a seed sample is all of the same line of descent or pedigree, it would be an advantage to grade out the small grains, if the best crop is desired.

Selection of wheat from the bin, and comparison of the value of large and small grains of wheat for seed purposes: This is the third year in which this line of work has been carried on. The experiment conducted in 1900 was as follows:

From a thoroughly well graded sample of Scotch Fife wheat there were selected eight hundred of the largest, plumpest, finest colored grains. From the same sample there were selected eight hundred of the smallest possible grains which were plump, hard and of similar fine quality. The weight of the eight hundred large grains equaled twenty-three and one half grams. The weight of the eight hundred small selected seeds was twelve and one-half grams, thus the same number of large grains weighed almost twice as much as the small grains. Each sample was seeded in a nicely prepared bed side by side in rows, so that the grains were approximately one and one-half inches apart in the rows. The bed, as in the case of the last experiment was surrounded by a double row of speltz to form a protection from the weather, and allow each plant of the selected seed wheat to have as nearly an equal chance with the others as possible. The grains were planted on the date of April 17th and all were up nicely by May 5th. The growth was not so even as that represented by the hand picked grains from the same heads. It was very noticeable that some stools were short and some were long, although they appeared to have equal chance. Both beds were harvested on July 24th by pulling. The roots were dusted and the crop allowed to mature as a whole in a dry room.

The following comparisons may be drawn: The total weight

of the straw and grains produced from eight hundred grains was six thousand eight hundred and fifty-seven grams.

The total weight of straw and grain produced from eight hundred small grains was six thousand two hundred and six grams, leaving an advantage in favor of the product from the large grains of 651 grams, or a gain of over 10.4, 10 per cent in favor of the product from the large grains.

Comparison No. 2: The dried heads were clipped from the straw close to the head in each case. The total weight of heads from the 800 large grains was 2,482 grams. The total weight of heads from 800 small grains was 2,203 grams, leaving a difference of 279 grams or about 12.6-10 per cent advantage in favor of the large seed. This shows quite a marked gain in favor of the large seed in this sort of selection. It demonstrates quite clearly that the small grains from the bin are not of as good value as the large ones, even though the small grains were selected with great care in regard to their physical qualities. It is a good evidence in favor of the recommendation that before sowing any sample of seed it will be of advantage to grade out the grains of small size. As, in this selection, all the grains selected were of the finest quality, the evidence is of all the more importance, as in case of injury, the small grain could certainly not have any advantage over the large grain. There also appear to be plants within a variety which tend to produce plants of a small type.

The growth of wheat from immature seed: The department has again made a test upon the growth of wheat from different grades of immature wheat. In order that the test might be as accurate as possible the grain was cut at different stages of maturity during the harvest of '99, even cuttings being made from the same plot of Scotch Fife wheat. In order that the samples might be under as equal conditions of harvesting and curing as possible, the heads of each sample were cut off from the straw just ten inches below the head. The bunches were cured in a dry room and kept in the straw until the date of seeding in 1900.

Sample No. 1: The first cutting was made July 28th, 1899, when the grain was very immature, hardly in the milk stage. When cured the grains were very much shrivelled.

Sample No. 2 was cut August 2 when the grains were just in the milk stage.

Sample No. 3 was cut August 10th, when the grains were just approaching the dough stage.

Sample No. 4 was cut August 17th when the grains were near maturity, slightly past the dough stage.

Sample No. 5 was cut August 28th, one month after the first sample was cut, the grain at this time being dead ripe.

The different samples were threshed April 11, 1900, and every sample tested in a Geneva germinator at the room temperature.

Each sample gave 100 per cent of germination, that is, all of the grains grew. The peculiarity of the germination was that the most rapid growth from the first was made by the most immature samples, that is: the properly cured immature grain will germinate more speedily than thoroughly matured grain of the same strain. There was a marked difference in the strength of the germination, the sprouts from the immature grain being many times longer at the end of the germination test than those from the mature wheat, while the latter were three to four times as strong in cross diameter. All were planted under what were supposed to be equal conditions on the date of April 12th. April 24th all plants were nicely up, the plants from the immature seed growing out of the ground a little quicker than those from the more mature ones. From the start the grains from the most mature samples produced plants of stronger, steadier growth. The season was very dry and after six weeks' growth it was very evident that the plants from the two most mature samples were very much the strongest. The first rain, however, due to an accident of the ground, gave the advantage of moisture to rows No. 1 and 2 which grew nearest the road ditch some six feet away. Though the rains were light during the season the ditch accumulated enough moisture to give the immature seed very much the advantage with reference to obtainable moisture. At harvest time the crop was very apparently better from the immature than from the mature seed. Thus no conclusions can be drawn from the experiment, except from the observations made upon the first growths. There is, however, a lesson in regard to farming methods to be drawn from the experiment. Preparation of the soil and good seed each have much influence upon the growth of a crop. Because one may procure a fine crop of grain from a poor quality of grain or seed one year, it should not be supposed that such seed is to be relied upon under all conditions. Under equal conditions this experiment could have shown but one point, viz: the great superiority of the properly matured plump grains.

Work in stinking smut of wheat in 1900: The following observations were made upon the growth of stinking smut (*Tilletia*) of wheat, to determine the question of whether smut winters over in the ground so as to produce a large amount of smut in the following crop, to observe the effect of weather and soil conditions upon the development of smut in the crop and the effect of the depth of planting.

Experiment No. 1: To test the wintering of smut in the ground. A plot of ground was selected upon which a large crop of smut was raised in 1899. The wheat in that year was very smutty, showing 47 per cent of smutted heads in the product. The grain upon this plot was allowed to thoroughly ripen. One

portion of the crop was harvested by a binder and the bundles removed, as is done in the ordinary farm methods. On the other half of the plot the grain was allowed to fall to the ground without being harvested. In the fall the stubble ground was plowed, also a portion of the unharvested crop was plowed under. On April 12th half of the remaining ground was plowed in the usual manner. The remainder was disked by means of an ordinary disk harrow.

On April 12th, the same day of the spring plowing, five plots were laid out across this ground, so that each plot would run across these differently treated pieces of land, and the plots were then seeded as follows:

No. 1 to untreated wheat selected from the agricultural college bins.

Plot No. 2 was seeded to the same sort of wheat which had been treated in the standard formaldehyde solution as used for the prevention of smut (one pound to forty-five gallons of water.)

Plot No. 3 was seeded to the same sort of wheat which was treated for fifteen minutes in hot water at 133 degrees Fahrenheit.

Plot No. 4, same grain as last, treated after the same manner and afterwards dusted or smutted with smut spores which were raised in 1898. The powdered smut used was thus two years old.

Plot No. 5 was seeded to similarly treated grain, in which the smut used was one year old. The smut in each case had been kept in the balls open to the action of the air, at ordinary room temperature in the laboratory.

It was possible from this experiment to learn a number of points with regard to the growth of smut. The plots showed the following results in the development of smut at harvest time.

Plot No. 1 by actual count of the heads to the extent of 1,000 showed the following per centages of smut:

Smut on the disked portion of the plot	.3 per cent
Smut on the fall plowed stubble portion of the plot	1.0 per cent
Smut on the spring plowed, straw lodged portion of plot	.9 per cent

PLOT NO. 2.

Smut on the disked portion of the plot	.0 per cent
Smut on the fall plowed stubble portion of the plot	.1 per cent
Smut on the spring plowed, straw lodged portion of plot	.1 per cent

PLOT NO. 3.

Smut on the disked portion of the plot	.3 per cent
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Smut on the fall plowed stubble portion of the plot	.3 per cent
Smut on the spring plowed, straw lodged portion of the plot	.1 per cent

PLOT NO. 4.

Smut on the disked portion of the plot	12.6 per cent
Smut on the fall plowed stubble portion of the plot	21.0 per cent
Smut on the spring plowed straw lodged portion of the plot	21.0 per cent

PLOT NO. 5.

Smut on the disked portion of the plot	17.9 per cent
Smut on the fall plowed stubble portion of plot..	34.0 per cent
Smut on the spring plowed straw lodged portion of plot	47.4 per cent

It is very plain that though a very large amount of smut must have fallen to the ground upon the straw lodged portion of each of these plots in 1899, yet there was not a marked gain of the amount of smut produced in 1900, either upon plowed land or upon disked land.

Studies of the smut balls found on the ground at seeding time in 1900, showed that the smut spores in these balls retained their viability when placed in the germinator they made good growths. No explanation can therefore be made of the lack of increase of smut in the crop in the presence of this abundance of smut, which had fallen to the ground, except that the spores failed to get distributed that any number of them might come in direct contact with the young wheat as it was coming out of the ground. A small amount of smut grew upon all of the plots. It is in those plots that some smut may originate in a crop from smut balls which fall to the ground during the previous harvest, but it is again demonstrated as I have done in a number of previous tests that the amount of smut which may originate this way is so slight as to be of no economic importance in a general crop. This will especially be true because in ordinary methods of harvesting nearly all of the smut balls are removed by the removal of the unthreshed grain from the field.

Smut which is two years old has not lost its capability to produce smut in a crop, if the wheat has been stored in the ordinary manner, thus those who have smutty wheat over one year old must expect to treat it the same as they would if it were only one year old. See for example the results obtained in plots 4 and 5 of this experiment. The one year old smut produced more smut in the crop than the two year old, but I was able to produce 21 per cent of smutted heads by the use of the two year old smut spores in the infection test.

The Influence of Smut Upon the Doughing of Flour and Bread Making: The statement is usually made that stinking smut injures the rising qualities of bread making the dough stringy and irregular in its rising qualities, usually with a tendency to run. With the view of ascertaining the influence of the smut spores upon the baking qualities of flour, a number of tests were made. Tests were also made to determine what caused the darkening effect upon dough and the baked product.

The following is a short summary of the work done. A good sample of flour of the brand of Fargo's Best was selected and 8 1-2 ounce loaves of bread were baked from it.

The loaves of bread were made as follows:

Flour, one even cupful.

Pure smut spores, screened from pulverized smut balls, two tablespoonsful.

Sugar, two teaspoonsful.

Salt, one teaspoonful.

Lard, one teaspoonful.

Potato yeast, one tablespoonful.

Water, one cupful or to proper consistency.

Set to rise.

A number of other loaves were made in which varying quantities of the smut were placed, some in larger amounts and some in less than in this example. Other loaves were baked by the same recipe without smut at the same time, for check or comparison.

To summarize the results, the flour containing the smut spores acted no differently, except in being colored, from that which did not contain the smut spores. It was properly raised in the same length of time, the action of the dough not being noticeably different. When baked the characteristic shape and form of the loaves and the texture was not noticeably different, except for the color due to the presence of the smut spores in the smutted sample. When cut fresh there was not enough smut to give any perceptible difference in odor. When tested there was not enough smut present to give any perceptibly different taste. In color, however, the loaf was almost black when two tablespoonsful of smut was added to the flour, so black that no one would think of eating it. The conclusions to be drawn from a number of these tests leave no chance for doubt. The smut spores, of themselves, have no effect upon the doughing and baking qualities of the flour.

It is a matter of interest whether the color was due to the actual presence of the spores or whether the coloring matter was solubly.

Microscopic examinations of bread showed two points. The smut spores kept their original cellular form and essential struc-

ture. They remained of normal color and there was no apparent coloring of the surrounding starch and dough or bread substance. Thus it was found that the coloring matter of smut spores is not soluble in the ordinary process of making bread. Later tests show that the color does not come out by the action of water or alcohol, and microscopic examination of flour samples containing smut showed that practically all of the smut spores go through the milling process unchanged in form, that is, the spores are sufficiently minute to escape the crushing action of the rollers.

The conclusion to be drawn concerning the color of smutty flour and bread is thus quite plain. It is due to the actual presence of the smut spores and not to any coloring matter which is dissolved or thrown off from them.

The Effect of Soil and Weather Conditions Upon the Development of Stinking Smut in Wheat: A number of observations upon the influence of weather and soil conditions upon the development of smut in a smut infected crop were made during the year, continuing the observations of previous years. Although the season of growth was one of almost complete drouth, showing for the months of May and June a total rainfall of less than three inches upon an already dry soil, yet the growth of smut in the ordinary planted crop of wheat was quite abundant.

Examination of numerous threshed products from all parts of the state show that this has been true throughout the state. Full as high, or even a higher percentage of smut has evidently been produced in many fields of the state as in the ordinary season. One discovery was made which is of interest as a matter of record here. In previous years I have demonstrated (see Bulletin No. 37.) that the greatest amount of smut would be produced when the soil conditions were the best possible for the growth of wheat from the seed. It was clearly shown that soil which was very wet, though not too wet to develop a reasonable crop of wheat was unfavorable to the development of smut. The very dry conditions of this year show by the experiments made, that though wheat may grow to a reasonable crop a very dry soil at and just following the germination period is unfavorable to the growth of smut.

A number of tests were made and the following table will quite clearly illustrate the point:

A TABLE SHOWING THE EFFECT OF DIFFERENT DEPTHS OF SEEDING IN A DRY SOIL UPON THE DEVELOPMENT OF SMUT IN THE WHEAT CROP.

Plot No.	Date of seeding and condition of seed	Depth of seeding	Per cent of smutted heads in the crop
6.....	April 17, very smutty; formaldehyde treated.....	{ $\frac{1}{4}$ plot 3 inches deep $\frac{1}{2}$ plot 1 inch deep	
7.....	April 17, same wheat untreated.....	{ $\frac{1}{2}$ plot 4 inches deep $\frac{1}{2}$ plot $\frac{3}{4}$ inch deep	53 4
8.....	April 21, Speltz thoroughly soaked in wheat smut.....	2 inches deep	
9.....	April 23, same wheat as 7, untreated....	{ $\frac{1}{2}$ plot 3 inches deep $\frac{1}{2}$ plot 1 inch deep	21 1½
10.....	April 24, same wheat treated in formaldehyde.....	2½ inches deep	
11.....	April 24, same seed untreated.....	1½ inches	9
12.....	May 3, same wheat untreated.....	{ $\frac{1}{2}$ plot 4 inches deep $\frac{1}{2}$ plot 1 inch deep	40 21
13.....	May 24, same wheat treated in formaldehyde.....	1 inch deep	
14.....	May 24, same wheat.....	1 inch deep	10
16.....	June 2, same wheat; formaldehyde treated.....	3 inches deep	Poor crop
17.....	June 2, same wheat untreated.....	3 inches deep	5—Poor crop

Summary: It is to be noticed that the formaldehyde treated samples did not produce any smut, no matter on what date they were seeded, or at what depth. The samples which were untreated produced a high percentage of smut when planted deep, as for example, in plots 7, 9 and 12, but when planted at a very shallow depth as in one half of plot 7, one half of plot 9, very little smut was produced in the crop. In plot 12 one half was planted four inches deep and showed 40 per cent of smut, one half was planted one inch deep and showed 21 per cent of smut. During all the period of planting time covered by these different experiments the beds upon which the samples were planted were in very fine garden condition, but the top soil was very loose and dry, so that grain planted less than an inch deep was in almost a dust bed, showing very little signs of moisture, while the grain which was planted over two inches deep lay in the ground, which was in good condition for germination.

The explanation of the effect of deep and shallow planting in the case of these plots seems to be that smut demands an atmospheric condition in the soil, which approaches saturation in order to give the best germination of the spores. When the wheat was planted at a depth of less than one inch, it got sufficient moisture to germinate but the smut spores did not, thus the deep planting was favorable to the production of smut. Another reason for there being more smut in the deep planted than in the shallow would be, in the fact, that it takes the young wheat plant a longer time to get out of the ground and develop that hardness of skin which prevents smut infection.

The practical point for farmers to remember is that some smut was produced even in the shallowest planting, and that plenty of it was produced when the wheat was put down an inch deep. In sowing wheat on a farming basis, it will not be practicable to take into consideration depth of seeding when trying to avoid smut; for an ordinary depth of drilling will put the grain deep enough for it to get the best possible amount of moisture, and yet not have it too deep for good growth. This depth will be found to furnish plenty of moisture to germinate smut spores.

An interesting point in connection with observations made upon these experiments was the point that when wheat was properly covered in a properly prepared seed bed, even during the past dry season, the shallowest planting, viz: one-half inch to one inch deep, always came up quicker and stronger, made a better growth throughout the season than wheat which was planted at depths greater than two inches. Wheat which was actually put down four inches almost failed to come up, being over a week later than that which was an inch deep, and when it did come was weak and spindling and never made a strong growth during the season.

* Note: It is probable that wheat which is actually seeded to a depth of one inch to one and one-half inches will make the best growth. There seems to be a depth which is somewhere in the neighborhood of one inch, at which it is not necessary for the wheat plant to send out a joint (node) before the permanent root formation and stooling takes place. When wheat is planted deeper than an inch, say two to three inches, it first sends up a small stem, forms a joint within about half an inch of the surface and from this joint sends out a new set of roots, the original roots down next to the seed dying. There is barely nutriment enough in a grain of wheat to make this first joint develop to a length of two and one-half to three inches without detriment.

The observation teaches that it is desirable to prepare a good even seed bed, so that the grain may be covered to a uniform depth of not to exceed two inches.

Selections of Wheat to Avoid Rust: An attempt was made during the growing season to select some plants from definite varieties which showed some marked capability of resistance to rusts. The dry season was very unfavorable to the development of rust and also of characteristic wheat plants. From a large number of observed plants I was unable to make any selection which gave promise of being more immune from rust than other plants.

THE WORK WITH POTATOES DURING THE SUMMER OF 1899.

The Selection of Potatoes From the Bin in an Attempt to Breed to Desired Shape of Tuber: During the work upon the selection of potatoes for seed and the study of the growth of potatoes from large and small tubers from the same vine or hill for the years 1894, 1895, 1896, 1897, 1898 and 1899, it was demonstrated that the matter of vine pedigree was a very important one. It was found that by selecting potatoes from the vine in the hill at digging time one could breed almost any desired form within the range of the usual shape of the variety, the strains breeding very true to the lines of selection. The work this year was an attempt to see if the knowledge gained was sufficient to allow one to select from a large bin of a given variety, potatoes of a certain shape, so that the majority of the hills would tend to reproduce that type of tuber. Twenty-one different plots were planted, using the best hand selected tubers obtainable. Four varieties were used in the test, Sunlit Star, Dakota Seeding, Trumbull and Early Ohio. The largest, best and nearly round tubers were selected from each variety, also the largest, best, typical long shaped tubers were selected from each variety. In the case of the Early Ohio a third selection was made of the largest, most irregular shaped tubers. These were planted upon an even quality of seed bed at an equal depth, each tuber being cut in two pieces of equal weight and placed surface down at a depth of six inches, and records were made upon all of the hills at digging time with regard to the prevailing shape of the tubers in each hill.

The following statements may be made from the work. No great success may be hoped for in selecting after this manner from the bin. On the average, a larger number of the hills tended to produce potatoes similar in shape to the patent tuber than tended to vary from it in the opposite direction from the selection. Thus, in hills from seed tubers selected because of their long oval shape, the general tendency was to produce tubers of the long oval shape, as shown by a summary of all the examinations made, several hundred hills in all. But in many cases tubers which were selected because of their long shape produced typical round tubers. The work emphasizes the fact that if one wishes to breed a certain form and quality of tuber, he must make the selection in the field from the vine, as previously demonstrated in Bulletin No. 30 of this station. It does show, however, that it is best to select from the bin the shape desired rather than to make no selection at all.

In the plots in which tubers of the Early Ohio variety were selected because of the large knob-shaped outgrowths upon

them, it was found that there was no apparent tendency to reproduce such knobs in the good even quality of soil which observation seems to bear out those made in previous years, that such outgrowths, especially upon the Early Ohio variety are due to bad mechanical and physical conditions of the soil.

The Comparison of the Value of the Stem and Bud or Tip End of Potato Tuber for Planting Purposes: The experiment station workers have made a very great number of tests upon this question. The work upon potato selection has allowed me to make observations upon this point, which I think constitute a better basis for conclusions than any experiments previously made, with which I am acquainted.

In making the studies upon selection I have attempted to use potatoes of approximately equal weight and equal weight of seed piece per hill, and have been particularly careful that the ground should be of equal quality of fertility and in equal mechanical condition. Have planted all comparative plots at same depth and have been very careful that they should have equal cultivation per hill. This year an opportunity was given to contrast the stem and tip end of each tuber. Tubers of approximately equal weight exceeding ten ounces were cut in halves diagonally, so that while the weight of each piece remained approximately the same. All of the eyes which are characteristically tip or "seed end" eyes remain upon the tip piece.

Each piece was planted cut surface down, six inches deep and four feet apart each way.

Very little difference was noticed in the growth throughout the season. All hills were hoed upon the same day and in the same manner and kept free from bugs and disease by proper methods of treatment. The crop made a very fine growth, so that the yield was very close to three pounds per hill on the average. At digging time, October 11th, when all hills were thoroughly matured the following records were taken: The typical shape of the tubers, the number of tubers, the number of stalks and the total weight of tubers in each hill.

The tip piece and stem piece of each parent tuber were planted in adjacent hills and made a very strong even growth throughout the season. The only noticeable difference was in the observation that the plants from the tip piece got out of the ground on the average a little sooner than those from the stem pieces. Before planting, the potatoes were in good condition, never having developed any sprouts and were treated with formaldehyde to prevent growth of scab.

The summary of results as tabulated is too extended for record here.

The following summary made from that table will indicate the general trend of the results.

First, the tubers in the hills raised from the tip and stem end of the same parent tuber have a general tendency to resemble each other in form, size and quality.

The hills from different parent tubers, even in the same variety, may produce tubers which vary from each other considerably in shape, texture of skin, size, etc.

The number of stalks and tubers produced from the complimentary pieces of one parent tuber showed a general tendency to equal each other, that is, they are more nearly of the same number than those found in hills which come from different parent tubers.

There was considerable variation in the number of stalks produced per hill by the tip and stem ends of the tubers. The number of times the stalks from the tip piece exceeded the stalks from the stem piece was 31.

The number of times the stalks from the stem piece exceeded the stalks from the tip piece, 29.

The number of times the stalks from the tip piece equalled the number of stalks from the stem piece was 28.

Total number of hills considered, 88.

The average number of stalks from hills from tip piece, 4.8.

The average number of stalks from hills from the stem piece, 5.2.

Comparison of number of tubers per hill—total number of hills considered, 87.

The number of times the tubers in hills from the tip pieces exceeded in number the tubers in hills from the stem pieces, 42.0.

The number of times the tubers from the stem piece exceeded the number of tubers from the tip piece, 35.

The number of times the tubers in the complimentary hills were equal was 10.

Average number of tubers, per hill, from the tip pieces, 14.8.

Average number of tubers, per hill, from stem pieces, 14.3.

The weight, per hill, contrasted—the number of complimentary pairs of hills considered, 55.

The number of times which the product per hill, from the tip piece exceeded in weight the product from the stem piece, 37.

The number of times which the product, per hill, from the stem pieces exceeded in weight the product from the tip pieces, 17.

The number of times which the products were equal in weight, per hill, 1.

Average weight of the tubers, per hill, from tip pieces, 47 oz.

Average weight of the tubers, per hill, from the stem pieces, 44 oz.

From these three comparisons it is seen in each case, with the

exception of the average number of stalks per hill, that the tendency of crop production is slightly in favor of the seed end piece. It was so slight, however, that no one could have noticed the difference as the crop was dug in the field, except that these records had been taken. I am inclined to think that with good sound selected, unsprouted seed tubers the difference in favor of the seed end, if any really exists, will be found to be so slight in ordinary methods of farm practice that it need not be taken into consideration.

I think the slight difference noticed in this experiment in favor of the hills grown from the seed end was really due to the fact that the early portion of the season just following planting time was abnormally dry. Under these conditions the seed end pieces seem to have had a slight advantage in the early period of growth in that they germinate a little more rapidly and thus got a slight advantage of start over the stem pieces, which was an advantage to them because of the long period of drouth immediately following:

°Root-fusion in Potatoes: The study of the question as to whether the roots of potatoes fuse in the soil and tend to bring about a crossing of varieties when growing side by side is an interesting one. It has often been claimed by farmers that potatoes will "mix in the hill" where different varieties are grown close to one another. I have thought that one of the ways in which this could occur, if it ever really does occur, would be through the fusion or union of the living roots which come in contact with each other, thus acting like grafts one upon another. In the year 1899 a small test of this was made in the green house, a number of tubers of different varieties being planted very closely together, so that the roots would become thoroughly entangled. These roots were washed and studied, but no evidence of root fusion was observed. During the present year two experiments were carried out, one in the green house and one in the field. The two varieties selected for experiment were Early Trumbull and Dakota Seedling, one a rather white potato producing greenish buds at the first growth from the eyes, and the other a pink skinned, deep eyed tuber producing dark pink buds or sprouts on the first growth from the tuber. It was thought that these two marked varieties would be good ones because of these color and skin characteristics. In order to place the young plants from each variety in as close relationship to each other in the hill as possible. Tubers of approximately the same shape and size were selected and cut longitudinally in halves. One-half from each variety of tuber was matched with a half from the other variety immediately while the cut surfaces were fresh. They were then bound together very tightly so that it would be possible for the cambium area of each half tuber to

fuse with that of the other if such a phenomenon could occur. One set of these tubers was planted in the green house in pots and the plants examined from time to time. There was no indication of root fusion observed from these plants. In the case of hills which were allowed to mature there were apparently typical tubers of each variety in each pot, but no tubers which showed an apparent mingling of the strains.

Fifty-seven hills, the seed tubers of which were prepared in a like manner, were planted in the field. These were allowed to grow to maturity and the products when dug were carefully considered to see if there were any indications of tubers which bore characters of two varieties. None were found which seemed in any way to be crosses. A number of the most likely in shape and color of skin were saved, washed, and laid away to sprout. The sprouts from these each showed in every case a typical characteristic of the parent variety, with no indications of crossing. The work will be continued another year in a still more careful manner, but so far as the two varieties are concerned there seems to be no indication that the roots or any part of the living plants will unite.

STUDIES UPON FLAX IN 1900.

Cause of Uneven Ripening of Flax: For a number of years the farmers in different parts of the state have complained of cases in which their flax crops have failed to ripen evenly, some saying that the same seed was used yet, on different pieces of ground, the results were wholly different, others that when seeded on different dates upon the same type of ground results were sometimes even ripening and sometimes uneven. After observing this feature of the flax crop for several years, it seemed that it was one worthy of consideration at the experiment station. A crop of flax which ripens evenly is, other things being equal, a paying one, because it can be harvested and cured easily, giving an even grade of seed. On the other hand a crop which has some ripe bolls, some green ones and some flowers gives a crop which the farmer does not know when to cut, and whenever he does harvest, it will result in a grade of seed of inferior quality. Besides there will often be a considerable loss from the shelling of the thorough matured bolls, and from injury in curing, due to green flax.

In order to study this question a piece of ground was prepared very evenly throughout all its parts and was selected because of its even quality with regard to fertility, physical condition, etc. Several supposed varieties of flax seed and several different grades of one variety as to quality of seed were selected to be used. These were contrasted by growing them upon the selected plot of soil in a number of different ways, sometimes, all

planted on the same day at the same depth, sometimes planted at very different depths. Plantings were made on April 12th and 24th, May 3rd, 10th, 17th, 23rd and 24th, June 1st, 6th, 12th, 21st and 27th and July 4th. The different depths of planting ranged from one-half inch to four inches deep. The even character of the growing season from the date of the first planting, it being one of almost constant drouth allowed of a very good judgment to be made as to the number of the causes which may produce uneven ripening in the crop.

The results of the observations from the growth of all of the different plots may be summarized as follows:

The irregular ripening of flax may be due to a large number of causes, the most prominent of which are the following:

1. Irregular Quality of the Seed Used. A sample of seed flax which is made up of large plump viable seeds when used upon good even quality of ground and given other conditions of an equal nature will tend to ripen evenly. If, however, there are a lot of part immature, part injured seeds in the sample the plant will come up at different dates, grow at varying rates and produce a crop which will ripen unevenly.

2. Irregular Depths of Planting: Even if the sample of flax seed is made up of good quality of grain, if these grains are put into the ground at different depths, they will tend to come up at different periods, grow at an irregular rate, and at harvest time it will be found that some plants are thoroughly mature and others just in the blossom.

3. Various types of injury to the plants after they come out of the ground tend to produce uneven ripening partly, perhaps, through abnormal branching. Those plants which have been much whipped and blown about or lodged by the wind branch profusely, so that the bolls are mature on some branches and other branches may bear green ones or even flowers. Young plants partly cut off by cut worms or other insects mature at a later period than those which are uninjured. Young plants which are frosted back after three or four inches high, if not too badly frozen may produce branches and reach maturity at a later date than those which escaped the frosts.

The experiment showed that it was possible to raise a crop which would mature equally, that is, all the plants at the same time, no matter at what date the sowing was done, provided the seeds were select as to quality, that is, very evenly alike, and were sown in a very equal manner as to depth and quality of the soil.

The obvious conclusion to be drawn is that farmers should grade their flax seed to as even quality as possible, prepare as even a seed bed as possible and try to seed it all at an even depth. It was found on comparison that all the different seedings for

the different dates, etc., that one inch and a half depth gave the best growth during the past season. Flax which was actually down four inches deep failed to reach the surface strong enough to grow.

The Effect of Frost Upon Young Flax: The question is often asked if, when young flax plants are killed back by the frost they will grow again. It depends upon whether the frost killed the young plant back below the two seed leaves. Numerous observations were made during the early part of this season and no plant grew again which had the top killed below the seed leaves. Also on the 7th of July a heavy dust storm prevailed in portions of the state. Much flax was cut off by shifting dust and injured so that it wilted down by the action of the hot dry winds. None of these young plants were found to grow again if the injury extended below the first seed leaves. A bed of young flax five inches high, which was in vigorous growing condition was selected for experiment. All of the young plants were cut off by a sharp knife just below the point of attachment of the first seed leaves. None of these plants so treated put out any new sprouts. Another bed was cut back, but the cutting was done so that the seed leaves were left on the stems. Such plants branch freely from the axils of the seed leaves. These results are to be expected, as buds are not normally formed below the first seed leaves in dicotyledonous plants.

The Effect of Frost Upon Immature Flax: Much flax was planted in this state later than the 4th of July. Such plantings seldom produced mature flax before frost. Very many half mature bolls were thus frozen in varying degrees. Those frozen before maturity together with the wet damp weather immediately following seems to have been the chief cause of the presence of so much so-called scaly flax seed. The scaly character is due principally to the adherence of the immature portions of the bolls to the flax seeds. Numerous questions have been asked concerning the value of such flax seed. The chemist of the station has determined that this immature flax seed has fully as large a percentage, by weight, of oil as mature flax. Numerous germination testing made within the last few weeks, tend, however, to show that the germinating quality of such seeds is very low. It will take the work of another season to demonstrate the comparative value of such immature seeds when used for crop production.

Flax Wilt: During the present summer flax throughout this region has been subject to an infectious disease which has done an enormous amount of damage. For want of a better name and because of the peculiar action of the disease upon the plants, I shall hereafter speak of this disease as Flax Wilt. It has not so far as I know been previously studied in this country unless

Professor Luger in his descriptions of the flax sickness described in Bulletin No. 13, pages 20 to 25, of the Minnesota Experiment Station was considering this type of diseases. I think from his descriptions that this is true. The disease has, however, been quite accurately described so far as its general features are concerned, by Mr. Paul Nypels* as occurring in Belgium. The article in which the description is given does not assign any definite cause, other than that it is possible that it might be due to bacterial infection.

The general features of the disease are as follows: It has been found that after flax has grown for a number of years upon the same land that the crop becomes very much lessened in yield. This may not properly be ascribed to impoverishment of the land, because the chemical analysis shows that such is evidently not a fact, and because other crops which take essentially the same food elements from the soil grow luxuriantly. Professor Luger has affirmed as his conclusion in the matter that flax is "unkind to flax", indicating that in some manner it leaves the ground in a condition unsuitable for the growth of flax plants. In a field of sick flax there will be found large areas in which the plants are first rather quickly wilted and later die to the ground giving the whole field a spotted appearance.

On the college rotation plots it was found that in the first year's crop there were an even scattering of a very few sick plants throughout the plots. On the second year plots a few more. On plots on which there had been three crops there were quite large areas of dead plants. On the plots upon which flax had grown for seven years the entire crop was killed and no matter how many times it was reseeded the young plants very soon died to the ground. In a field that is not too heavily diseased one is able to find sick plants at all ages. Some die as soon as they get out of the ground. Others become yellow and finally wilt as late as blossoming time, perhaps even mature a few pods before dying.

The department has carried out numerous observations and experiments upon this disease during the past season, which when some further work has been done, I desire to publish in bulletin form. It is sufficient to state here the following essential points.

1. The disease has been found to be due to a parasitic fungus.
2. This parasite produces an abundance of spores, and lives both in the soil and in the old decaying flax stubble.
3. The disease may be started in a new field by the transfer of dirt from an infected field.

* *Compte-rendu de la séance du 5 décembre, 1897, de la Société Royale de Botanique de Belgique.*

4. The disease may be transmitted to young healthy plants by infusions made from diseased plants.

5. Young healthy plants are uninjured by similar infusions made from healthy flax plants. This is contrary to the results obtained by Professor Luger. (See same citation.)

6. Observations upon a great number of fields in different parts of the state teach that the disease may be started in new or virgin soil by way of the seed flax. This is of much importance to farmers. It is not known how long this disease will remain in the soil when it once gets possession. Perhaps it may be found impossible to ever raise a good normal crop of flax upon the same soil again, thus great care should be taken in the procuring of flax seed to know that it has grown upon land which has not borne diseased flax plants. The action of the disease is peculiarly fitted to be effective in droughty conditions of the soil.

The fungus attacks the roots of the flax plants strongest in the neighborhood of the bottom of the furrow slice. The smaller roots quickly assume a pale darkish gray color, and finally the large root portions assume the same dead appearance and the plant rapidly wilts. Upon examination it is found that the parasite has filled vessels and tissues of the roots very thoroughly with its filaments. This is probably the explanation of why it did so much destruction during the past dry season, as there was very little moisture in the soil the plants were unable to make a rapid and vigorous growth and the fungus attacking the roots readily cut off the water supply from the leaves above, bringing about the typical wilting effect.

The study of the soil conditions in connection with the disease would seem to indicate that that preparation of the soil which would leave it in condition to best withstand drouth would be favorable to the flax plant and tend to produce a crop, when in a loose friable soil the disease would otherwise do great damage.

A large number of tests were made with the different fungicides and chemical substances, fertilizers, manures, etc., drilled into the soil with the seed in order to determine whether anything could be sowed with the seed which would prevent an attack upon the young plants when the ground was thoroughly diseased. These plantings were made upon the ground upon which a flax crop had completely died out on date of July 4th. Substances were placed in the drill in such quantities that it was feared that many of the young flax plants would be killed by the chemical nature of the treatment alone. A heavy shower on the day following the planting caused all of the plants to come up nicely. In nine days all of them had died to the ground thoroughly infected with the disease.

This set of experiments was radical enough in its nature to

teach that when the fungus has once infested the soil, it will be very difficult, if not impossible, to get any substance which will be effective against it and not injurious to the growing flax plants. The importance of procuring healthy seed is thus very much emphasized. There is much land in this state upon which flax has never been raised, and if possible to avoid it, the fungus should not be implanted in the land.

STUDIES UPON WEEDS IN 1900.

The Destruction of Weeds in Cereal Grains by Means of Chemicals Sprayed Upon the Foliage: In the tenth annual report I made a preliminary statement of the work which had been done in the line of the destruction of weeds in cereal grains by means of chemical sprays. Much interest has been taken in this subject by farmers and it was continued on as extensive a plan last season as time permitted. As stated in that report the work in the spring of 1899 gave much promises of success; so that we hope to be able to recommend that farmers use the method upon an extended scale. Later work, during 1899 and during the past season, teaches that in order to succeed each farmer will have to have much better judgment as to the time to spray than we had at first supposed.

It has been found that many conditions enter into the success of the work.

During the spring of 1899 very fine results were obtained by the use of commercial copper sulphate at the rate of one pound to four gallons of water, using at the rate of from ten to sixty gallons of solution per acre, according to the abundance of weeds.

The season was a rapid growing one, and young plants of king head, mustard, etc., died to the ground within a few hours after the application while the grain remain practically uninjured by the process. The work done during the summer of '99 and during the draughty conditions of 1900 demonstrated that these weeds do not always die down by the treatment so easily, indeed that in dry slow growing periods spraying should not be attempted.

Following the work in the spring of 1899, the following spraying tests were made:

1. Sodium arsenite in the following strengths and upon the dates listed. Applied to roadside weeds:

1. One ounce to four gallons August 1st, effective in two days. Too strong.

2. One ounce to three gallons, September 4th, effective in five days. Oldest not killed.

3. One ounce to three gallons, September 5th, effective in four days. All dead.

4. One ounce to two gallons, September 6th, effective in five days. All dead. (Too strong for timothy grass.)

5. Three ounces to four gallons, September 7th, effective in two days. Too strong.

6. One pound to 32 gallons, September 8th, effective on one-fifth acre Purslane.

7. One ounce to three gallons, September 11th, partly effective in five days.

8. One ounce to three gallons, September 13th, not effective.

Applied upon young weeds on summer fallow:

9. One ounce to three gallons, September 14th, not effective.

10. One ounce to two gallons, September 15th, effective.

11. One ounce to two gallons, September 18th, effective.

12. One ounce to three gallons, September 20th, not effective.

2. Sodium arsenate—applied to roadside weeds.

1. One ounce to four gallons, September 1st, not effective.

2. One ounce to three gallons, September 2nd. Plants recovered.

3. One ounce to two gallons, September 4th. Nearly effective.

4. One ounce to two gallons, September 5th. Not a success.

5. Three ounces to four gallons, September 6th. Not effective.

3. Copper sulphate applied to young weeds and wheat:

1. One ounce, chemically pure, to three gallons, September 13th. No effect.

2. One ounce, chemically pure, to three gallons, September 14th. Only slight effect.

3. One ounce, chemically pure, to four gallons, September 15th. No effect.

4. One ounce, chemically pure, two gallons, September 15th. Slight effect.

5. One ounce, commercial, to two gallons, September 18th. Slight effect.

6. One ounce, commercial, to three gallons, September 18th. No effect.

Salt applied to roadside weeds:

1. One pound to two gallons, September 4th. Effective.

2. Two pounds to one gallon, September 5th, effective. Too strong for wheat.

3. Three pounds to two gallons, September 6th. Effective in most cases.

4. Three pounds to four gallons, September 7th. Not effective.

5. One pound to one gallon, September 8th, effective. Too strong for wheat.

Salt applied to young weeds and cereals:

6. One pound to one gallon, September 14th. Not satisfactory. Injured grain plants. Did not kill weeds.

7. Three pounds to two gallons, September 15th. Not satisfactory as above.

8. One-half pound to one gallon. Not effective.

A number of other substances were tested without promise of particular value. The results of the work at this time of the year was unsatisfactory. No success may be hoped for in killing old weeds by means of chemicals. They withstand approximately as much injury as the cereals.

Destruction of Weeds by Spraying in 1900: The past spring, effort was made to work upon a scale extensive enough to afford a basis upon which recommendations could be made. The results have been discouraging to our hopes that an easy road to weed extermination had been reached, but very instructive and warrant further work, when taken in relation to the fine results accomplished in the spring of 1899, when it was shown that treatment easily doubled the yield of oats upon weedy ground.

No. of test	Date of test	Chemical used	Strength of solution	Area treated	General result of the treatment
1	May 22	Sodium arsenite	1 oz. to 3 gallons	4 sq. rods	No satisfactory results, mustard matured. Hot, dry and windy. Dried off too quickly.
2	May 22	Copper sulphate (commercial)	½ lb. to 3 gallons	4 sq. rods	Oats not permanently injured, mustard killed or stunted, effect quite good.
3	May 24	Copper sulphate	1 lb. to 4 gallons	4 sq. rods	Nearly a success. Oats injured a little, as enough rain fell to free the leaves of this chemical. For same reason the effect was spotted upon the mustard—as rain failed to spread the solution on the leaves.
4	May 24	Copper sulphate (commercial)	1 oz. to 3 gallons	4 sq. rods	Effective when upon thoroughly sprayed weeds, except <i>Thlaspi</i> . Some injury to oats. Too dry, hot and windy.
5	May 25	Copper sulphate (commercial)	1 lb. to 3 gallons	4 sq. rods	Success upon all young weeds. Too strong upon oats, if thoroughly wet with fine spray. Weather too hot, dry and windy. No growth, so oats could not recover as usual.
6	May 25	Sodium arsenite	2 ozs. to 3 gallons	4 sq. rods	Hurt oats more than last. Effect on weeds more irregular. Too strong for thorough application in this weather.
7	May 31	Copper sulphate (commercial)	1 lb. to 4 gallons	6 sq. rods	Slight rain June 1st. Wet weather success. Killed mustard, buckwheat, kinghead, young French weed, hurt the oats because of the dry time following, where too thoroughly sprayed.
No. 8	June 1, a. m.	Sodium arsenite.....	1 oz. to 2 gals. water.....	6 sq. rods	No result. Slight rain after application seems to have prevented all action of the arsenite.

No. of test	Date of test	Chemical used	Strength of Solution	Area treated	General result of the treatment
9	June 1.....	Copper sulphate (Com.)....	1 lb. to 4 gallons.....	8 sq. rods	Could not wet Hare's ear mustard. Effective on mustard and buckwheat. Success due to small shower during morning just previous to application, and one on June 3rd. Oats hurt, but recovered after 3rd. Dandelions killed to ground recover.
11	June 1, 4 P. M.	Sodium arsenite.....	1 oz. to 2 gallons.....	.....	Applied after rain. Killed all weeds. Too hard on oats when it was thoroughly applied.
12	June 1, 12 M...	Copper sulphate.....	1 lb. to 4 gals., 12 gallons....	$\frac{1}{4}$ Acre...	Hot, dry wind blowing—dried too quickly. Most mustard plants stunted some, but able to recover. The plants on this plot old and tough due to drouth.
13	June 2.....	Sodium arsenite.....	$\frac{1}{2}$ lb. to 12 gallons.....	$\frac{1}{4}$ Acre...	Weeds too old and tough due to the dry weather and slow growth. Mustard plants grown in this dry windy weather will not wet with the solution as they do if quickly grown. No success.
14	June 12, after shower	Copper sulphate, (Com.)...	1 lb. to 4 gallons, 12 gals.	$\frac{1}{4}$ Acre...	Shower 9 A. M. to 11 A. M., June 13, youngest weeds effectively killed, old ones wilting. June 21st, grain hurt some, oldest weeds recovering.
15	June 2, after shower	Sodium arsenite.....	1 lb. to 32 gals., 12 gals. used..	$\frac{1}{4}$ Acre...	Result about as in last, more irregular. Grain hurt more than in last, and more weeds recovered although many were killed.

A study of these results and the observations made on the field teach that both these chemicals may be effectively used against all weeds which have a surface upon which the solution will spread.

Hare's ear mustard (*Conringia Orientale*) and French weed (*Thlaspi arvense*) are hard to wet except when very young. Spraying will not be effective upon these unless quite young. Common mustard and kinghead are easily wet and readily die in a few hours when in rapid growth conditions.

It is useless to expect desirable results by spraying in drouthy windy weather. Even mustard quickly becomes too hardy and can resist, while the central growth from the cereals not being rapid at such times, these plants also become injured by the cumulative effect of the poisons.

Recommendations: If both grain plants and weeds are rapidly growing success can be scored with either sodium arsenite or copper sulphate. The latter is the most reliable.

1. Use copper sulphate at rate of one pound to four gallons of water or,

2. Use sodium arsenite at the rate of one pound to thirty gallons of water.

3. Unless the weeds are evenly distributed spray only the weed areas.

4. Carry the solution in a hand spray cart or in barrel or tank spray upon wagon, according to work to be done.

5. One man to work the force pump and one or more to walk about the wagon with spray hose and nozzle can rapidly and effectively cover the ground.

6. The nozzles should be carried upon poles at least ten feet long so as to allow rapid movement to avoid waste of solution when weeds are scattering.

7. Select nozzles which throw fine drops rather than misty sprays.

8. Spray just after a rain rather than just before.

9. Do not spray unless both grain plants and weeds are succulent, rapidly growing.

10. Spray just after most of the young weeds are out of the ground at least before any mustard is in blossom. Preferably before the cereal has reached a height sufficient to form stems say not to exceed 5 to 10 inches high.

11. Success is not sure to follow; for weather conditions have such invariable influence on this work, but to combat mustard where too thick to pull I believe nothing can be lost in the process in an ordinary growing season, and there is much to gain.

The Life of Weed Seeds in the Red River Valley Soil: Record was made in the tenth annual report of this station, page 26, of the outline of an experiment to test the growth of weed seeds

planted at different depths in the heavy soil of the college farm. The place selected for the experiment was somewhat lower and less well drained than the average soil of the valley, the water table often reaching to within a few inches of the surface for short periods of time during the wet season. No seeds have been taken up yet for tests, records only being made of those which grew during the fall of 1899 and during the summer of 1900. The former records are to be had from the tenth annual report, pages 26 and 27. The growths for this year are given below.

April 7th. Seeds of Shepperd's Purse (*Capsella*). French weed (*Thlaspi*), mustard (*Brassica*), which were one inch deep were coming up in large numbers.

April 21st. Greater Ragweed, Kinghead (*Ambrosia*) was up from one to two inch plantings.

Mustard and French weed a few from 2 inches depth.

Wild Buckwheat (*Polygonum*) was putting up plants from one and two inch plantings.

April 28th. Wild oat (*Avena*), showed a few plants from one inch, two inch and three inch plantings.

August 5th. Pigeon grass (*Setaria*) showed a few plants from one inch plantings. Mustard also showed a few plants at this date from three inches deep.

The following summaries of growths from the different beds represent the different growths made. All plants were pulled upon the date of the count.

Bed No. 1. Shepperd's Purse (*Capsella bursa pastoris*.)

May 12th. From one inch plantings, pulled 230 plants from three inches of row. The others pulled but not counted.

June 5th. From one inch plantings, pulled 70 plants from the row.

Bed No. 2. French Weed (*Thlaspi arvense*).

May 12th. From one inch plantings, pulled 783 seedlings.

May 12th. From two inch plantings, pulled 16 seedlings.

June 5th. From one inch plantings, pulled 2 seedlings.

August 28th. From one inch plantings, pulled 160 seedlings.

Bed No. 3. Pigeon Grass (*Setaria vividis*).

May 18th. From one inch plantings, pulled 1104 seedlings.

May 18th. From two inch plantings, pulled 366 seedlings.

June 5th. From one inch plantings, pulled 190 seedlings.

June 5th. From two inch plantings, pulled 140 seedlings.

June 5th. From three inch plantings, pulled 169 seedlings.

Bed No. 4. Kinghead (*Ambrosia trifida*).

May 12th. From one inch plantings, pulled 100 seedlings.

May 12th.	From one inch plantings, pulled 217 seedlings.
May 12th.	From three inch plantings, pulled 91 seedlings.
June 5th.	From one inch plantings, pulled 2 seedlings.
June 5th.	From two inch plantings, pulled 1 seedling.
June 5th.	From three inch plantings, pulled 12 seedlings.
June 5th.	From four inch plantings, pulled 9 seedlings.

Bed No. 5. Common Mustard (*Brassica sinapistrum*).

May 18th.	From one inch plantings, pulled 730 seedlings.
May 18th.	From two inch plantings, pulled 635 seedlings.
May 18th.	From three inch plantings, pulled 290 seedlings.
June 5th.	From one inch plantings, pulled 20 seedlings.
June 5th.	From two inch plantings, pulled 19 seedlings.

Bed No. 6. Wild Buckwheat (*Polygonum Convolvulus*).

May 12th.	From one inch plantings, pulled 137 seedlings.
May 12th.	From two inch plantings, pulled 64 seedlings.
May 12th.	From three inch plantings, pulled 80 seedlings.

Bed No. 7. Wild Oat (*Avena fatua*).

May 12th.	From one inch plantings, pulled 43 seedlings.
May 12th.	From two inch plantings, pulled 31 seedlings.
May 12th.	From three inch plantings, pulled 40 seedlings.
June 5th.	From one inch plantings, pulled 23 seedlings.
June 5th.	From two inch plantings, pulled no seedlings.
June 5th.	From three inch plantings, pulled 13 seedlings.

It is interesting to notice the effect of depth of planting. No seedling has reached the surface from a greater depth than four inches.

Shepherd's Purse has not sent up plants from a depth of over one inch.

French weed has no record below two inches.

Mustard and pigeon grass sent up the most plants from one inch depth.

Kinghead did best from two inches, did well from three inches, and sent up some late plants from a depth of four inches. Wild oats did equally well from one inch to three inches and sent up some plants from four inches deep.

These members of the mustard family were the earliest to start, closely followed by the Kinghead.

These figures as to depth are instruction as to how deep to cultivate a summer fallow. Four inches seems to be almost the exact depth if wild oats and kinghead are to be killed, and at least three inches for mustard, but not deeper.

Records will be taken upon these beds during 1901.

The Seed Bearing Plants of the State: The work of systematizing the collection of seed bearing plants of the state now in

the Herbarium and of constructing a preliminary list has been continued. The list has been published as Experiment Station Bulletin No. 46 under the title "Preliminary List of the Seed Bearing Plants of North Dakota." With the possible exception of the grasses and a few of the smaller orders of plants, the list is in no manner to be considered a complete one. As a beginning and aid it is hoped that it may prove of benefit to many.

Correspondence: One of the ways in which this department of the station finds that it can be of much service to the residents of the state is along the line of question answering by mail. Since the last report there have been answered 417 letters upon botanical or biological subjects as applied to farm matters or practice. These chiefly relate to the subjects of disease, weeds, seed examination or to general questions upon which the department has or is experimenting.

Judging from the tendency of many farmers to make use of inferior grain for seed, and the desire manifested to learn along the lines of seed studies, a department devoted entirely to seed examination testing and investigation would be of great economic value to the state.

An Observation Upon the Growth of Red Clover Seed: The common belief that Red clover (*Trifolium pratense*) needs the presence of bumble bees or other large insects to carry pollen, in order that the ovules may be fertilized, I think must be discarded. This plant is very prolific in the production of mature seeds in all parts of this state, practically every flower of a head being fertile. The bumble bee is a very scarce insect in North Dakota, seldom being seen. I do not know of any other insects sufficiently numerous to visit all the flowers in all of the heads of all the fields of North Dakota or indeed for any state. The plant, it seems, must be fertilized chiefly by wind carried pollen.

Assistance: As general assistant in the department of biology of the college and station, Mr. Lawrence R. Waldron has rendered efficient service in all of the different lines of station work.

Respectfully submitted,

HENRY L. BOLLEY, Botanist.

AGRICULTURAL DEPARTMENT.

To Director J. H. Worst:

During the past year this department has devoted a large amount of time to farmers' institute work.

Personally I have taken part in twelve or fifteen such meetings, including the grain growers convention and the state Chautauqua assembly, while the assistant agriculturist has been called upon for a similar amount of time.

The number of special letters in reply to specific questions has also greatly increased and requires a large amount of time and energy. The number of such letters answered during the past season was 239 and during some months numbered three to five a day.

Wheat experiments have received much work during the past season. Selection and breeding with wheat has been carried forward in an extended way and with good success.

The awarding of a gold medal by the Paris exposition authorities to this station upon a display of the results of breeding and selecting wheat as shown by this department indicates the degree of success which that work is meeting.

The results from the other work done with wheat, oats, barley, spelt, flax, flax and wheat mixed, buckwheat, beans and from trials of the value of old and sprouted seeds for planting are published in detail in this report.

An extended study of Indian corn has been made, the results for which I hope to submit to you in bulletin form, at an early date. The loss of a large quantity of our pedigreed varieties of corn by fire January 4th will cause the time of our being able to distribute them by sale to be delayed two years or more.

I desire to report that small quantities of seed of each distinct variety of corn and of all cereals and other plants of any particular importance had been placed in other buildings as a matter of precaution, and by reason of that fact have been saved from extinction. The quality of seed wheat for distribution by sale and also the seed corn which was ready to be put out in the same way were in other buildings and consequently are preserved and being sent out.

The rotation trial was continued during the past year and added more information than it has during any single season it

was instituted. The limited space available in this report makes it necessary to hold that data for publication in bulletin form at a later date.

The study in methods of cultivation and the preservation of soil moisture were given extended study during the past year and yielded some valuable information both as to the actual holding of moisture by tillage methods and in the yields of various crops produced.

A study of the effect of different methods of cultivation upon the blowing or drifting of soil has been carried on but while some progress has been made it is proving a difficult line of experimentation.

The study of the root systems of plants was given a limited amount of study and makes an interesting record of their behavior during an extraordinary dry season.

Pasturing trials with sheep and hogs upon cereals and rape were begun during the past season and a limited amount of good data was secured.

Feeding trials with horses and mules have been continued, a limited way and will form a good basis for future work of a similar character.

Feeding trials with horses and mules have been continued, a report upon which I made you in bulletin No. 45 last September.

The distribution of wheat by sale is coming fully up to my expectation. I have reports of 13,050 bushels of it in pure condition now in the hands of farmers in eleven counties in this state. This has all sprung from the distribution by sale of small samples by this station, the amount ranging from thirty pounds to five bushels in quantity.

These growers are acting as farm seedmen by selling this wheat to their neighbors.

J. H. SHEPPERD.

GRAIN AND FORAGE CROPS.

This report gives the result of trials carried on in 1899 and 1900 in rather extended detail. In cases where the results for the past two years are but a continuation of work which has been in progress for several seasons the average results for the entire time have been given and conclusions drawn from the entire list of results.

The crop work of this department for the past two years has been chiefly a continuation of the experiments reported and discussed in Bulletin No. 39. The study of flax has been extended and will be carried forward in considerable detail during the coming season.

The soil methods of handling and general conditions described in Bulletin No. 39 hold for the work of the past two seasons. Wheat was attacked by rust early in the season of 1899, which has probably reduced both the yield and grade, while in 1900 the extreme drouth which prevailed caused a light yield of grain.

As each sample of seed of the various grains, etc., is received by this department it is given a number in our record book, under which is noted the character of the seed, from whom received, date of receipt, etc. This number is called a "Record Number" and goes with each variety of seed as a part of its name, on our records. In publishing the results of our experiments it has been found convenient and advisable to number each variety in the several classes of grains, etc., in the order in which they are published. This number is called a "Bulletin Number." This system has been carried out with wheat, oats and barley from the start, but some of the products reported upon in Bulletin No. 39, were designated by their "Record Number." In this publication wherever the variety number has been changed, attention has been called to the fact by foot notes.

VARIETIES OF WHEAT.

Sixty-three varieties of wheat were grown in this trial in 1899. The land used for the trial grew a crop of corn in 1898 and was fall plowed late. The grain was sown from May 5th to 8th and harvest was completed August 12th.

Table 1 gives a description and record of the varieties grown in 1899.

TABLE I.—VARIETIES OF WHEAT.

Bulletin Number	Variety	Where from Originally	First crop grown at this station		Days maturing	Length of stem	Bearded, smooth or velvety chaff	In	Length of heads	Grain				Average yield per acre—1898 and 1899 crops—
			Yr	Grade						P C	Lb	Bu	Yield per acre	
23	Red Fife.....	Agricultural College, Guelph, Ont., Can....	1892	98	41	Sm'h	3	3	3	90	58½	25	28.5	
50	Wellman's Fife.....	Experiment Farm, Brandon, Manitoba.....	1892	99	40	"	"	3	2	95	59	24.3	29.3	
66	Exp. Station Fife.....	J. B. Power, Power, N. D.....	1892	98	39	"	"	2¾	2	95	59½	21.7	29.7	
120	Glyndon (774).....	Russia, by Minn. Exp. Station.....	1892	98	40	"	"	2¾	2	95	59	23.2	28.1	
146	Bolton's Blue Stem.....	Thos. Bolton, Park River, N. D.....	1893	98	43	Velv.	3¾	3	3	90	57¾	26.6	31.5	
148	C. & C. Land Co.'s Fife.....	C. & C. Land Co., Jamestown, N. D.....	1894	98	42	Sm'h	3	3	3	95	58	23.6	29.9	
149	Minn. No. 19, White Russian.....	Minn. Exp. Station.....	1896	98	41	"	"	3½	2	90	58½	23.8	31	
151	Minn. No. 10½, Glyndon (711).....	Minn. Exp. Station, same as N. D. No. 10½*.....	1896	98	40	"	"	3	2	90	59	24.8	29.9	
155	Minn. No. 146, Bolton's Blue Stem.....	Minn. Exp. Station, same as Bolton's B. S. No. 146*.....	1896	98	43	Velv.	3	3	2	95	58½	26.5	31	
176	Glyndon (811) Fife.....	Minn. Exp. Station, same as N. D. No. 123*.....	1896	98	42	Sm'h	3	3	2	95	58½	25.8	31.9	
178	†Selected Power's Fife.....	N. D. No. 66..... original seed, same as Prof. Wm. Saunders, Ottawa, Can., in 1894,	1896	97	39	"	"	2¾	3	90	58½	24.2	30.2	
194	Advance.....	by Minn. Exp. Station.....	1896	96	41	Ber'd	2¾	3	3	90	58½	22.7	27.8	
195	Crown.....	Prof. Wm. Saunders, Ottawa, Can., in 1894,	1896	94	39	"	"	2¾	2	95	58½	22.3	27.9	
196	Stanely.....	by Minn. Exp. Station.....	1896	94	39	Sm'h	2¾	3	3	90	58½	21.2	26.6	
197	Preston.....	Prof. Wm. Saunders, Ottawa, Can., in 1894,	1896	93	43	Ber'd	3	3	3	50	58¾	27.6	32.8	
198	Percy.....	by Minn. Exp. Station.....	1896	92	42	Sm'h	2¾	Red.	2	50	57½	22.8	27.1	
202	Minn. No. 19, White Russian.....	Minn. Exp. Station, same as N. D. No. 149.....	1897	98	44	"	3½	2	2	95	59¼	25.3	27.7	
203	Minn. No. 51, Haynes' Blue Stem.....	Minn. Exp. Station, same as N. D. No. 51*.....	1897	98	45	Velv.	3½	2	2	90	58	26.4	29.9	
204	Minn. No. 66, Power's Fife.....	originated by L. H. Haynes, Fargo, N. D.....	1897	98	41	Sm'h	3	2	2	95	58½	24.5	28.2	
207	Minn. No. 116, Glyndon (753).....	Minn. Exp. Station, same as N. D. No. 66*, 116*.....	1897	98	40	"	3	2	2	95	58½	23.2	28.2	

208	Minn. No. 146, Bolton's Blue Stem.....	1897	98	45	Velv.	3½	2 N	90	53	26.4	30.9
209	Minn. No. 149, †Selected Power's Fife.....	1898	99	40	Sm'h	3	2 N	95	59½	24.	28.9
210	Minn. No. 155, †Selected Glyndon (816) Fife	1898	99	40	"	3	2 N	95	59½	23.6	29.4
211	Minn. No. 157, †Selected Glyndon (753) Fife	1898	98	41	"	3	2 N	95	58.	24.5	30.5
212	Minn. No. 163, †Selected Glyndon (811) Fife	1898	97	42	"	3	2 N	95	58½	25.9	31.6
213	Minn. No. 167, †Selected Glyndon (761) Fife	1898	98	43	"	2½	2 N	75	59.	24.8	29.8
214	Minn. No. 169, †Selected Haynes' Blue Stem	1898	99	45	Velv.	3½	2 N	95	57¾	25.7	32.1
215	Minn. No. 171, †Selected Rysting's Fife.....	1898	99	42	Sm'h	3½	2 N	98	58½	26.6	32.4
216	Minn. No. 181, †Selected McKendry's Fife..	1898	99	40	"	3½	2 N	95	59½	24.6	30.1
217	Minn. No. 185, Advance.....	1898	95	40	Ber'd	3	2 N	90	59	21.9	27.5
218	Minn. No. 188, Preston.....	1898	94	39	"	2½	3 N	50	59	26.2	31.3
219	Russian.....	1898	99	39	"	2½	Rej.	50	55¾	17.1	17.4
220	Haynes' Pedigree Blue Stem.....	1898	99	44	Velv.	3½	3 N	57	57	23.5	
221	Defiance.....	1899	97	38	Sm'h	2½	Rej.	Soft	60	34.9	
222	Pererodka, U. S. No. 2,954.....	1899	97	47	Ber'd	2½	2 N	Soft	60½	30.1	
223	Kubanka, U. S. No. 2,953.....	1899	97	47	"	2½	3 N	Soft	60½	30.1	
224	Russian, U. S. No. 2,955.....	1899	97	40	"	2½	3 N	80	59	14.5	
225	Marvel.....	1899	98	42	Velv.	3½	2 N	95	57¾	23.2	
226	Selected Rysting's Fife.....	1899	99	43	"	3½	2 N	98	58½	26.	
227	"	1899	99	41	Sm'h	3½	2 N	95	58½	26.4	
228	*Minn. No. 51, Haynes' Blue Stem.....	1899	99	42	Velv.	3½	2 N	90	57	24.7	
229	*Minn. No. 66, Power's Fife.....	1899	97	41	Sm'h	2½	2 N	95	59	23.5	
230	*Minn. No. 105, Glyndon (711).....	1899	97	41	"	2½	2 N	95	58½	22.3	
231	*Minn. No. 146, Bolton's Blue Stem.....	1899	98	44	Velv.	3½	2 N	90	57	23.2	
232	*Minn. No. 163, Glyndon (711).....	1899	96	41	Sm'h	2½	2 N	90	57½	22.4	
233	Minn. No. 185, Advance.....	1899	92	39	Ber'd	3	3 N	90	58½	19.5	
234	Minn. No. 188, Preston.....	1899	92	40	"	2½	2 N	50	59½	23.9	
235	Red Fife.....	1899	96	42	Sm'h	2½	2 N	90	59	23.2	
236	Wellman's Fife.....	1899	95	45	"	3½	2 N	90	58½	26.9	
237	Early Wonder.....	1899	95	41	"	3	2 N	90	59	24.	
238	Advance.....	1899	92	40	Ber'd	3	2 N	50	59	24.4	
239	Preston.....	1899	92	41	"	3½	3 N	25	59½	24.2	
240	Stanley.....	1899	91	38	Sm'h	2½	2 N	90	59	22.1	
241	Crown.....	1899	91	39	Ber'd	2½	Rej.	Soft	59½	18.9	
242	Percy.....	1899	92	37	Sm'h	2½	2 N	50	58½	24.6	
243	Improved Saskatchewan Fife.....	1899	96	38	"	2½	2 N	50	59	21.4	
244	Selected Blue Stem.....	1899	99	40	Velv.	3½	2 N	90	59	19.7	
245	Montana Spring Fife.....	1899	98	41	Sm'h	3½	3 N	90	58½	21.2	
246	Spring Club.....	1899	93	37	"	2½	Rej.	....	41	8.2	

*Varieties were all originally grown at this sta., (see bulletins 10, 11, 23 and 39.) The Minn. Exp. Sta. secured seed from this sta. in 1893. †Selections made from single plants grown at Power, N. D. in 1892, by Prof. W. M. Hays, now of the Minn. Exp. Station; seed taken by him to that station in 1893.

The varieties which are marked "selected" are new improved kinds originated by breeding and selection. This station has bred and selected wheat for nine years. In 1898 twelve of the best of the forty kinds grown the previous year were seeded in large quantity. The new kinds are very promising and represent the best of many thousand plants, grown from the best original kind found in extensive variety trials.

TABLE II. VARIETIES OF WHEAT GIVING LARGEST YIELD IN 1899.

Bulletin No.	Variety	Grade	Hard wheat	Weight per bu.		Yield per acre
				Per ct.	lb.	Bu.
222	Pererodka, U. S. No. 2954	2 N	soft		60	34.9
223	Kubanka, U. S. No. 2953...	3 N	"		60 $\frac{1}{2}$	30.1
197	Preston.....	3 N	50		58 $\frac{3}{4}$	27.6
236	Wellman's Fife.....	2 N	90		58 $\frac{3}{4}$	26.9
215	Selected Rysting's Fife....	2 N	98		58 $\frac{1}{2}$	26.6
146	Bolton's Blue Stem.....	3 N	90		57 $\frac{3}{4}$	26.5
203	Haynes' Blue Stem.....	2 N	90		58	26.4
212	Selected Glyndon Fife (811)	2 N	95		58 $\frac{1}{2}$	25.9
176	Glyndon Fife (811).....	2 N	95		58 $\frac{1}{2}$	25.8
214	Selected Haynes' Blue Stem	2 N	95		57 $\frac{3}{4}$	25.7
202	White Russian.....	2 N	95		59 $\frac{1}{4}$	25.3
23	Red Fife.....	3 N	90		58 $\frac{1}{2}$	25
151	Glyndon (711).....	2 N	90		59	24.8
213	Selected Glyndon Fife (761)	2 N	75		59	24.8
66	Experiment Station Fife...	2 N	95		59 $\frac{1}{2}$	24.7

TABLE III. VARIETIES WHEAT GIVING LARGEST AVERAGE YIELDS FOR TWO YEARS, 1898 and 1899.

Bulletin No.	Variety	Grade		Hard wheat avg.	Weight per bu.		Yield per acre
		1898	1899		Per ct	lb.	bu.
197	Preston.....	1 N	3 N	63		59 $\frac{3}{4}$	32.8
215	Selected Rysting's Fife....	1 N	2 N	90		59 $\frac{3}{8}$	32.4
214	Selected Haynes' Blue Stem	1 N	2 N	90		59	32.1
212	Selected Glyndon Fife (811)	1 N	2 N	93		60	31.6
146	Bolton's Blue Stem.....	1 N	3 N	85		58 $\frac{3}{8}$	31.5
176	Glyndon Fife (811).....	1 N	2 N	95		95 $\frac{1}{4}$	31.4
149	White Russian.....	2 N	3 N	58		58 $\frac{3}{8}$	31.0
211	Selected Glyndon Fife (753)	1 N	2 N	95		59 $\frac{1}{2}$	30.5
178	Selected Power's Fife.....	1 N	2 N	96		59 $\frac{1}{2}$	30.2
216	Selected McKendry's Fife..	1 N	2 N	88		59 $\frac{7}{8}$	30.1
151	Glyndon (711).....	1 N	2 N	88		59 $\frac{3}{4}$	29.9
203	Haynes' Blue Stem.....	1 N	2 N	90		59 $\frac{1}{4}$	29.9
148	C. & C. Land Co's Fife....	1 N	3 N	93		59 $\frac{1}{8}$	29.9
213	Selected Glyndon Fife (761)	2 N	2 N	63		60	29.8
66	Experiment Station Fife...	1 N	2 N	90		60 $\frac{1}{8}$	29.7

TABLE IV. VARIETIES OF WHEAT TESTED FOR SIX YEARS, 1893, '94, '95, '97, '98 and '99.

Bulletin No.	Variety	Grade					Hard Wheat avg.	Yield per acre avg.
		1893	1894	1895	1898	1899	Per ct.	Bu.
146	Bolton's B. S.	1 N	1 N	1 N	1 N	3 N	82	24.2
66	Experiment station Fife.....	1 H	1 H	1 H	1 N	2 N	89	23.5
23	Red Fife.....	1 H	1 H	1 H	1 N	3 N	86	22.8
120	Glyndon (774).....	1 H	1 H	1 H	1 N	2 N	90	22.8

Numbers 222 and 223 Russian varieties imported by the U. S. department of agriculture, from the Russian crop of 1898, out-yielded our best standard fife and blue stem varieties four and eight-tenths and eight bushels per acre, respectively. Unfortunately they belong to a class known as flint wheat, and botanically as *Triticum durum*, instead of *Triticum vulgare* or common wheat. This thrifty heavy yielding wheat does not mill well and while it is good for making maccaroni and can be used in preparing breakfast foods, there is little demand for it and consequently nothing to be made by growing it in its present form in a hard wheat district.

It is a better grade of wheat than the wild goose wheat variety, but is like it in being a flint wheat. These new Russian wheats will be placed in the breeding trials where they may infuse their blood with good effect into some of the standard strains of the fife and blue stem sorts.

Preston No. 197, the wheat which ranked third in yield in 1899 and first in the average for 1898 and 1899 is a bearded wheat, rather soft in quality and low in grade. It was originated by Dr. William Saunders at the Dominion Experiment station, Ottawa, Canada, by cross-breeding and selection. It is an early wheat and hardy, in addition to being a large yielder.

Minnesota No. 171, a new fife variety originated by the Minnesota station has ranked highest in our trials—all points considered—during the past two years and has been increased in quantity until we expect to be able to distribute it by sale, in 1902. Minnesota No. 169, a blue stem variety descended from seed originally obtained from Thos. Bolton, Park River, N. D., ranked fifth in the two year trial, but yielded a fraction of a bushel less per acre than Minnesota No. 163, the fife variety which this station is now sending out. The station is now prepared to distribute a limited amount of seed wheat by sale, to citizens of this state.

There were fifty-one variety of wheat in the trial of 1900. The varieties were grown upon land which produced corn in 1899, but the corn crop consisted of several experiments with different varieties, different methods of cultivation, different thickness of planting, etc., and by reason of that fact the land was not subjected to exactly the same condition of cropping. It became evident before harvest time that there was a greater difference in the wheat growing upon the several plots, than could be reasonably attributed to the difference in varieties. Careful observation showed that the different methods of cropping with corn in 1899, had produced a strong influence on the wheat crop in the dry season of 1900.

When the grain was threshed and weighed it was found that the yields varied from ten to twenty-nine bushels per acre, too large a difference to be attributed to difference in variety alone. It was found, however, that the differences in yield could be accounted for in part by the early maturing of some varieties of wheat and the late maturing of others, the later maturing sorts having been unusually favored by the rains which fell during the latter part of the growing season.

As a trial of varieties the results were not considered fair and the yields have not been included in this report.

.CHANGING SEED WHEAT.

In this trial of a change of seed wheat with the Minnesota station, the breed or variety effect has been carefully eliminated by using seed descended from grain which was originally grown at this station. In other words the grain compared in this trial came originally from the same bag of seed.

In the comparison of twenty-three samples of home grown seed, with that which had spent a vacation of from one to nine years at the Minnesota station, the home grown seed outyielded that which had been grown for a time in Minnesota except in a single case. The decrease is marked for the first and second years after it was returned, while the third crop showed the effect to only a slight degree. There was no marked difference in the grade and weight per bushel of the grain produced. The accompanying summarized table gives a more detailed statement of the yields secured.

TABLE V.—SUMMARIZED RESULTS OF EXPERIMENTS IN CHANGING SEED WHEAT.

No. of Trials	Kind of Seed	Average yield per acre	Difference in favor of older seed
		Bu.	Bu. per acre
8	Home grown, 3 to 9 years	21.6	3.0
	New, direct from Minnesota	18.6	
5	Home grown, 2 years	29.0	1.3
	New, direct from Minnesota	27.7	
4	Home grown, 1 year	16.2	2.1
	New, direct from Minnesota	14.1	
6	Home grown, 2, 3 and 9 years	32.4	2.9
	Home grown, 1 year	29.5	
23	Home grown, 2, 3 and 9 years	25.1	2.44
	New seed or home grown, 1 year	22.66	

The average results from twenty-three trials, with the wheat which had been grown by the Minnesota station in a manner similar to our own method of handling it, show a loss in yield of nearly two and a half bushels per acre with no practical difference in the grade.

In the spring of 1899 a change of seed of several varieties of wheat with the Dominion Experiment station at Ottawa, Canada, was secured. Our seed of the varieties tried had come originally from the Central station at Ottawa, and hence was of the same breeding. The results from this trial are not so uniform and regular as those from the Minnesota trial and can scarcely be taken as an indication of either inferior or superior yields. The tabulated statement submitted herewith gives the data recorded in 1899.

TABLE VI.—SHOWING RESULTS OF CHANGING SEED WHEAT WITH THE DOMINION EXPERIMENT STATION, OTTAWA, CANADA. CROP OF 1899.

Variety	Seed grown at this station since 1896.			Seed received from Ottawa in 1899.			Difference of yield in favor of old wheat
	Yield per acre	Grade	Hard wheat	Yield per acre	Grade	Hard wheat	
	Bu.		Per ct	Bu.		Per ct	Bushels
Advance.....	22.7	3 N	90	24.4	2 N	50	-1.7
Crown.....	22.3	2 N	95	24.6	rej't	soft	-2.3
Percy.....	22.8	rej't	50	18.9	2 N	50	3.9
Preston.....	27.6	3 N	50	24.2	3 N	25	3.4
Stanley.....	21.2	3 N	90	22.1	2 N	90	0.9
Average.....	23.3			22.8			0.5

QUANTITY OF SEED WHEAT PER ACRE.

Experiment station fife 66 was the seed used in this trial.

Observations made on the crop of 1899 show that the thick sown wheat ripened a day or two earlier than the thin sown grain. The straw was weaker and lodged more on the thick sown plots. Ten per cent of the grain seeded at the rate of eight pecks per acre was lodged while that sown at the rate of three pecks per acre did not lodge. The latter however, rusted worse than the thick sown wheat. The thick sown wheat did not grow so high and had shorter and smaller heads than the thin sown grain.

In 1900 the trial was made on ground which grew potatoes in 1899. The test was considered fair and the yields and weights per bushel of this crop have been included in Table VII. In this trial the wheat varied less than in 1899. The height of straw varied from twenty-eight inches for the thickest sown grain to thirty-one inches for that sown thinnest. The heads were of good length and quite uniform in size, and there was very little difference in the time of ripening, all plots being harvested on the same date, July 1st. Table VII gives some of the data collected on this subject:

TABLE VII.—AMOUNT OF SEED PER ACRE.

Plot Number	Seed sown per acre	Crop of 1899						Crop of 1900		Average for '98, '99, 1900	Average for seven trials
		Stand	Height	Length of Heads	Grade	Hard Wheat	Weight per bu.	Yield per acre	Weight per bu.		
	Pks.	In.	In.	In.	Per cent	bu.	bu.	bu.	bu.	bu.	bu.
1	3	42½	3¼	3¼	95	59	60½	23.9	25.1	18.3	
2	4	41	3¼	3¼	95	58½	60	23.9	24.9	19.3	
3	4½	42	3¼	3¼	95	58½	59¼	23.5	25.1	19.1	
4	5	41	3	3	95	58½	59¼	23.6	25.9	20.1	
5	5½	41	2¾	2¾	95	58½	60	26.2	27.1	19.8	
6	6	41	2½	2½	95	58¾	59¾	26.0	27.4		
7	7	40	2½	2½	95	58¾					
8	8	40	2¼	2¼	95	58¾					

Five and one-half pecks of seed wheat per acre has given the largest average yield for the several trials. It will be noticed that there is a lack of uniformity in the yield as compared with the rate of seeding, and during the entire trial the variation in that way has been noticed.

VARIETIES OF OATS.

Twenty-five varieties of oats have been grown in this trial during the past two years, and eight of them have been in the trial for six years or more. Several of the old varieties reported upon in Bulletin No. 39 have been discarded and a number of new ones added to the list.

In 1899 all varieties of oats were sown on May 8th and 9th at the rate of two and one-fourth bushels per acre. Harvesting began on August 2nd and was completed August 10th. None of the varieties were seriously injured by rust, there being only a trace of it visible, except with three varieties. The kinds which rusted were Black Beauty, Tobolsk and Swedish Select. Archangel also rusted but to a less degree than the others.

In 1900 the oats were sown April 20th and 21st on fall plowed land, which grew wheat in 1899. The seed was treated with the standard formaldehyde solution, for smut, and the drill was set to sow three bushels of dry oats per acre, which made the actual rate of sowing two and one-half bushels of dry oats per acre. The grain came up well, but the drouth continued and the plants failed to stool properly, causing the stand to average thin on all plots. The straw made a very short growth, averaging from fifteen to eighteen inches in height for the early varieties and twenty-two to twenty-six inches for the later sorts. Rains in the early part of July came too late to save the crop, although late maturing varieties seem to have been benefitted to some extent, as shown by the smaller yields received from the early maturing sorts. The crop failed to ripen evenly and wet weather caused much loss and damage to the quality of the grain.

The 1900 crop was so inferior in growth and in the quality of grain produced that it was considered more nearly fair to use the descriptive notes taken for the crop of 1899, and they have been introduced into Table VIII.

TABLE VIII.—VARIETIES OF OATS.

Bulletin Number	Variety.	Where from	First crop grown at this station	Crop of 1899								Crop of 1900		Average yield per acre for two crops, 1899 and 1900	
				Days maturing	Length of straw	Form of heads	Length of heads	Color of berry.	Size of berry	Shape of berry	Weight per bushel	Yield per acre, 1899	Weight per bushel		Yield per acre
2	Archangel.....	College Farm.....	1892	85	In. 49	Br'ch wh'l'd	In. 8	white	medium	shrt & plu'p	lb 41½	bu. 69.1	lb 37¾	bu. 23.9	46.5
12	Race Horse.....	Maule.....	1893	94	43	side	8	"	med. large	medium	39½	65.0	35	33.6	49.3
19	Black Beauty.....	N. B. & G. Co.....	1893	86	40	wh'l'd	7¼	brown	medium	"	37½	73.9	34½	19.0	46.5
26	Tartarian.....	Angell.....	1893	94	41	side	8	white	large	long & plu'p.	39¾	65.0	34	34.9	50.0
35	American White Banner	Minn. Exp. Sta., origin-ally from Maule.....	1894	89	42	wh'l'd	8	light br'ze white	medium large	medium	38½	74.3	36¾	25.9	50.1
39	White Russian.....	Minn. Exp. Sta.....	1894	91	40	side	8½	"	"	"	39	65.9	35	38.6	52.3
40	Lincoln.....	" " " origin-ally from Angell.....	1894	88	41	wh'l'd	7	light cre'm dark br'wn	medium	med. short medium	39¾	67.9	36¾	26.8	47.4
41	Lee Oats.....	J. F. Lee, Fingal, N.D.	1897	90	36	side	7	"	"	"	36	57.7	35	34.6	46.2
42	U. S. No. 3.....	Russia, by U. S. Dept. Agriculture.....	1898	88	43	wh'l'd	8	light cre'm yel. & wh.	medium	"	35¾	72.0	36¾	25.6	48.8
43	Danish Island.....	W. Atlee Burpee & Co.	1898	88	44	"	8	"	"	med. short	37½	66.8	37	26.6	46.7
44	Nameless White.....	Salzer Seed Co.....	1898	85	50	wh'l'd	9	white	small	shrt & plu'p	44½	66.9	38½	22.0	44.5
45	Silver Mine.....	" " ".....	1898	87	44	"	8	"	med. large	medium	38½	81.1	39	23.2	52.2
46	Selected Black Beauty..	A selection from Black Beauty No. 19.....	1898	86	40½	"	8	dark br'wn	medium	medium	38¾	76.3	36½	15.4	45.9
48	The Lannii, U.S. No. 2963	Russia, by U. S. Dept. of Agriculture.....	1899	87	50	"	9	light cre'm	"	"	37	79.9	35¾	22.0	51.0
50	Tobolsk, U.S. No. 2800...	Russia, by U. S. Dept. of Agriculture.....	1899	87	45	"	8	"	"	shrt & plu'p	42¾	70.6	34½	21.9	46.3

TABLE VIII.—VARIETIES OF OATS.—Continued.

Bulletin Number	Variety	Where From	First crop grown at this station	Crop of 1899.								Crop of 1900		Average yield per acre for two crops, 1899 and 1900	
				Days maturing	Length of straw	Form of heads	Length of heads	Color of berry	Size of berry	Shape of berry	Weight per bushel	Yield per acre, 1899	Weight per bushel		Yield per acre
51	Swedish sel U.S. No. 2788	Russia, by U. S. Dept. of Agriculture	1899	88	46	Br'oh	8	white	medium	shrt & plu'p	39¾	bu.	lb	bu.	bu.
52	German Rust Proof.....	Sionx Falls Seed Co..	1899	89	46	"	8	light cream	"	medium	37¼	75.4	38¼	23.0	49.2
54	Sorted Tartarian.....	No. 26, hand picked...	1899	94	47	side	9	white	large	l'ng & plu'p	39	69.3	35	36.7	53.0
55	New Zealand.....	Northrup, King & Co.	1899	94	47	"	9	"	"	long	38½	67.7	35	34.8	51.3
56	Bonanza King.....	L. L. May & Co.....	1899	88	46	wh'ld	8	"	"	l'ng & plu'p	38½	77.7	36½	34.9	56.3
58	Early Gothland, Minn. 26	From Minn. Exp. Sta.	1899	88	43	"	8	"	"	"	38½	77.0	34¾	34.8	55.9
60	White Wonder, Minn. 32	Minn. Exp. Sta.....	1899	88	43	"	8	yel. & wh.	med. small	medium	37¾	75.6	36	27.4	51.5
61	White Russian, Minn. 35	Minn. Exp. Sta.....	1899	88	47	"	8¼	white	medium	med. short	38½	69.5	35¾	22.7	46.1
63	White Bronze.....	Washington Exp. Sta.	1899	89	42	"	7	light br'ze	"	medium	35½	68.8	35¼	40.3	54.6
64	Negro Wonder.....	Farmer Seed Co.....	1899	89	46	side	8½	dark br'wn	med. large	long	37¼	63.6	37	45.7	54.7
65	White Shouen.....	Farmer Seed Co.....	1899	88	45	wh'ld	8	light br'ze	medium	med. short	40½	67.1	37½	23.6	45.4
80	Mold's Black Beauty. .	Northrup, King & Co..	1900	late	"	side	"	black	med. large	med. long	....	....	34½	33.0	

TABLE IX.—VARIETIES OF OATS GIVING LARGEST YIELDS
IN 1900.

Bulletin No.	Variety	Yield per Acre Bushels	Weight per Bushel Pounds	Harvest Season
64	Negro Wonder.....	45.7	37	Med. late.
63	White Bronze.....	40.3	35¼	Med. late.
39	White Russian.....	38.6	35	Late.
54	Sorted Tartarian.....	36.7	35	Late.
26	Tartarian.....	34.9	34	Late.
56	Bonanza King.....	34.9	36½	Med. early
55	New Zealand.....	34.8	35	Late.
58	Early Gothland.....	34.8	34¾	Med. early
41	Lee's Black.....	34.6	35	Med. late.
12	Race Horse.....	33.6	35	Late.

TABLE X.—VARIETIES OF OATS GIVING LARGEST YIELDS
IN 1899.

Bulletin No.	Variety	Yield per Acre Bushels	Weight per Bushel Pounds	Harvest Season
45	Silver Mine.....	81.1	38½	Early.
48	Thelannii.....	79.9	37	Early.
52	German Rust Proof.....	78.2	37¼	Medium.
56	Bonanza King.....	77.7	38½	Med. early.
58	Early Gothland.....	77.0	38½	Med. early.
46	Selected Black Beauty.....	76.3	38¼	Early.
60	White Wonder.....	75.6	37¾	Med. early.
51	Swedish Select.....	75.4	39¾	Med. early.
35	American White Banner.....	74.3	38½	Medium.
42	U. S. No. 3.....	72.0	35¾	Med. early.

The early maturing varieties yielded best in 1899. In 1898 the late varieties were the better yielders, and they were also the better yielders in 1900.

TABLE XI.—VARIETIES OF OATS GIVING LARGEST YIELDS.
AVERAGE FOR SIX TRIALS, 1894, 1895, 1897, 1898, 1899, AND 1900.

Bulletin No.	Variety	Yield per Acre Bushels	Harvest Season
26	Tartarian.....	57.4	Late.
35	American White Banner.....	55.4	Med. early.
12	Race Horse.....	54.2	Late.
19	Black Beauty.....	53.5	Early.
2	Archangel.....	53.4	Early.
39	White Russian.....	51.8	Late.
40	Lincoln.....	51.6	Med. early

In comparing the yields of the several varieties for a series of years, the results seem to be somewhat in favor of the late maturing kinds as opposed to the early sorts. Those varieties, however, which are neither late nor early, but which have a medium harvest season are practically equal to the late sorts in the trials at this station, and such varieties would suffer less when the late oat growing season proves to be adverse.

VARIETIES OF BARLEY.

Twenty-five varieties of barley were grown in the field trial in 1899. The column headed "First Crop Grown at this Station" in the table tells when the seed was received and the column headed "Where From" indicates the source of the variety.

The grain was sown May 9th and 10th at the rate of two bushels per acre. No. 33 was received from the U. S. department of agriculture and had been badly injured by their treatment for destroying insects and disease germs. Harvesting began July 21st and was completed August 2nd (except No. 33 which was not ripe until August 14th.) The column in the table marked "Days Maturing" will indicate which varieties ripen early and which are late in maturing.

In 1900 the trial with barley varieties was conducted in the same field and under similar conditions to those already described for the trials with the varieties of oats. The growth of straw was thin and short, the height ranging from ten to twenty inches, the early maturing sorts giving a much poorer growth and a lighter yield than the late varieties. The varieties were sown on April 23rd and 24th, while harvesting was begun on July 14th and completed on August 3rd. Table XII gives the results of the two years' trial, the descriptions being for the crop of 1899.

TABLE XII.—VARIETIES OF BARLEY.

Bulletin No.	Variety	Where from	First crop grown at this station.	Crop of 1899								Crop of 1900		
				Days maturing	Length of straw	Length of head.	No. of rows per head	Length of beards	Size of berry	Color of berry	Weight per bushel	Yield per acre	Weight per bushel	Yield per acre
Year				In.	28	2½	2	In.	Medium	Med. dark ...	Lb.	Bu.	Lb.	Bu.
1893	Champion of Vermont..	Thorburn	1893	76	28	2½	2	4%	Medium	Med. dark ...	50½	42.7	50½	42.7
1893	Chevalier	Salzer	1893	82	34	2¾	2	5	Large	Light	49¾	49.0	49¾	49.0
1893	Mansury	N., B. & G. Co.	1893	82	35	2¾	2	5	Med. large...	Yellow	50½	46.1	50½	46.1
1893	Highland Chief.....	Maule.....	1893	84	34	3	2	5	Medium	Light	51	42.7	51	42.7
1893	Highland Scotch	Angell.....	1893	84	33	3½	2	4½	Medium	Light	51	45.2	51	45.2
1893	Success.....	Minn. Exp. Station	1893	84	33	3	2	5	Med. large..	Light	50½	47.2	50½	47.2
1893	Hoover's Hulless.....	Bisbee, N. D.	1893	73	..	.....	..	.....	Medium	Med. dark...	56	25.4	56	25.4
1897	McEwan Hulless.....	Park River, N. D.	1897	72	25	2%	2	5	Med. large...	Dark	59½	38.2	56	38.2
1898	U. S. No. 5.....	Russia, by U. S. Dept. of Agriculture.....	1898	75	32	2	6	3%	Medium	Light.....	48¾	44.1	43½	43½
1898	Dakota Silver Beardless.....	.....	1898	75	34	2¾	6	.....	Medium	Med. dark...	48½	39.5	42¾	38.8
1898	Salzer's Silver King....	Salzer Seed Co.....	1898	75	33	2%	6	3%	Medium	Light.....	49½	44.7	42¾	42¾
1898	Minn. No. 6, Mansury...	Minn. Exp. Station	1898	77	32	2¾	6	3%	Med. large..	Light.....	49½	50.3	40½	40½
1898	Minn. No. 7, Champion of Vermont	Minn. Exp. Station	1898	76	29	2½	2	5	Med. large..	Dark	50¾	40.6	43	43
1898	Minn. No. 15, French Chevalier	Minn. Exp. Station	1898	83	29	2¾	2	4½	Med. large...	Med. dark...	51	50.6	50	50
1898	Minn. No. 21, Odessa	Minn. Exp. Station	1898	75	32	2	6	3%	Medium	Yellow.....	49¾	49.1	40½	40½

Bulletin No.

TABLE XII.—VARIETIES OF BARLEY.—Continued.

Bulletin No.	Variety	Where From	First crop grown at this station	Crop of 1899								Crop of 1900		Average yield per acre, two crops	
				Days maturing	Length of straw	Length of heads	No. of rows per head	Length of beards	Size of berry	Color of berry	Weight per bushel	Yield per acre	Weight per bushel		Yield per acre
29	Minn. No. 28, Bernard's.	Minn. Exp. Station.....	1898	73	32	2½	6	4½	Medium	Light.....	49¾	42.4	44½	12.2	27.2
30	Minn No. 86, Culver's..	Minn. Exp. Station.....	1898	85	34	3½	2	5	Med large..	White	50	49.2	45½	25.4	37.3
31	Minn. No. 100, Houston's Golden Queen.....	Minn. Exp. Station..... Russia, by U. S. Dept. of Agriculture	1898	77	33	2¼	6	4	Medium	Light.....	49	46.5	44½	11.4	28.9
32	Sisolsk, U. S. No. 2962..		1899	75	33	2½	6	4½	Med. large..	White	45¾	52.1	43¼	14.1	33.1
33	Kostroma, U. S. No. 2793.	Russia, by U. S. Dept. of Agriculture	1899	94	31	2½	2	6	Med. large..	Dark	48¾	28.1	47¼	20.2	24.2
34	Salzer's Beardless.....		1899	71	28	2	6	.....	Med. large..	Dark	44¾	43.1	37	8.9	26.0
35	White Hulless.....	Northrup, King & Co. ...	1899	72	25	1¾	6	.....	Medium	Med. dark...	56½	32.7	52	6.1	19.4
36	Minn. No. 6, Mansury ...	Minn. Exp. Station.....	1899	76	33	2½	6	3½	Med. large..	Light	50¾	54.3	42	12.2	33.2
37	Minn. No. 27, Success...	Minn. Exp. Station.....	1899	71	28	2½	6	.....	Medium ...	Med. dark...	44¾	36.1			
38	Minn. No. 105.....	Minn. Exp. Station.....	1899	76	33	2¼	6	4	Medium	Yellow	48	50.6	41	17.2	33.9
39	English	G. Cooper, Gardner, N. D.....	1899	*			2	.....	Large	Yellow					
40	Turkestan Hallless, U. S. No. 977.....	U. S. Dept. of Agr.....	1899				6	.....	Large	Yellow			47½	13.6	
41	Minn. No. 6, Mansury...	Minn. Exp. Station.....	1900				6	.....	Med. large..	Yellow			40	11.4	
42	New Beardless.....	N., King & Co.....	1900	*			6	.....	Medium	Yellow			36¾	8.6	

* Early. † Late.

TABLE XIII.—VARIETIES OF BARLEY GIVING LARGEST YIELD
IN 1900.

Bulletin No.	Variety	Weight per bushel	Yield per acre	Harvest season
		lb	bu.	
19	Success	47	25.8	Late
30	Culver's	45½	25.4	Late
33	Kostroma	47½	20.2	Late
27	French Chevalier	50	22.2	Late
38	Minnesota No. 105	41	17.2	Med. early
7	Two-rowed Mansury	46	16.8	Late
32	Sisolsk	43¾	14.1	Med. early
23	Dakota Silver, Beardless	42¾	13.8	Med. early
39	English	47½	13.6	Late
21	McEwan Hulless	56	13.0	Early
28	Odessa	40½	13.0	Early

TABLE XIV.—VARIETIES OF BARLEY GIVING LARGEST YIELDS,
AVERAGE FOR TWO YEARS, 1899 AND 1900.

Bulletin No.	Variety	Yield per acre	Harvest season
		bu.	
19	Success	37.5	Late
30	Culver's	37.3	Late
27	French Chevalier	35.4	Late
38	Minnesota No. 105	33.9	Med. early
36	Mansury	33.2	Med. early
32	Sisolsk	33.1	Med. early
7	Two-rowed Mansury	31.5	Late
28	Odessa	31.0	Early

TABLE XV.—VARIETIES OF BARLEY GIVING LARGEST YIELDS,
AVERAGE FOR THREE YEARS, 1898, 1899 AND 1900.

Bulletin No.	Variety	Yield per acre	Harvest season
		bu.	
27	French Chevalier	39.4	Late
30	Culver's	38.9	Late
25	Mansury	37	Med. early
28	Odessa	37	Early
24	Salzer's Silver King	34.6	Med. early
29	Bernard's	34.4	Med. early

The late maturing varieties of barley gave enough heavier yield in 1900 to affect the average yield for three years to such a degree as to cause the late kinds to rank highest. In considering that average the unusual and extreme conditions of the past season should be kept in mind, as such seasons in the past have been very rare.

Early maturing barley has an advantage in being harvested and off of the ground early, which permits early plowing of the land with partial summer fallow effect.

VARIETIES OF SPELT.

Four varieties of spelt were sown in the field trial in 1899. Of these Nos. 3 and 4 came directly from Russia, and contrary to our experience in 1898[†] both produced good crops, No. 3 giving a larger yield than the old home grown seed, (No. 2).

The grain was sown May 10th. The drill was set to sow two and one-half bushels of barley per acre, except for No. 3, which was sown at the rate of two and three-fourths bushels of barley per acre on account of having a larger berry. None of the grain was sown thick enough. The trials at this station indicates that the drill should be set to sow two and one-half to three bushels per acre of oats to seed spelt thick enough. It does not seem to tiller or stool as much as the other grains do. The varieties were all harvested August 5th. Table XVI gives the results in detail.

TABLE XVI.—VARIETIES OF SPELT—CROP OF 1899.

Bulletin No.	Variety	Where from	First crop	Days matur'g	Height	Length of Heads	Weight per bushel	Yield per acre
			Year		in.	in.	lb	bu.
*1	U. S. No. 4.....	Russia.....	1898	86	39	1¾	32½	52.7
†2	Common.....	G. A. Welch, Bismarck, N.D.	1897	86	37	1½	37½	69.1
3	Yaroslaf, U. S. No. 2789.....	Russia.....	1899	87	37	1¾	37½	74.1
4	Ufa, U. S. No. 2959.....	Russia.....	1899	87	42	2	....	52.6

Spelt weighs about the same as oats and is calculated above on the basis of thirty-two pounds per bushel. No. 2 yielded 2338

* This variety is published in bulletin No. 39 as No. 106.

† This variety is published in bulletin No. 39 as No. 305.

pounds per acre in 1898. This makes an average for the two years of 2274 pounds or 71.1 bushels per acre.

SPELT IN 1900.

Only the two best yielding varieties were continued in the trial in 1900.

The seed was treated with formaldehyde for smut and sown April 25th at the rate of two and one-half bushels of dry grain per acre. The grain came up well and made a fair stand. It was ripe and harvested July 30th, requiring about the same period for growth as the medium late varieties of oats and barley.

The yield was as follows:

Common spelt No. 2—32.69 bushels per acre.

Yaroslaf Spelt No. 3—28.56 bushels per acre.

The average height of straw was twenty-one inches and the average weight of the grain per bushel was thirty-nine pounds. Common spelt had the longer straw by two inches and produced slightly larger heads, while the grain weighed two pounds more per bushel than that from the Russian (Yaroslaf) seed.

It will be interesting to notice the comparative yields of spelt, barley and oats in the dry season of 1900. As already noted in the discussion under varieties of oats and barley, the season of ripening in the crop of 1900, seemed to be, to a large extent, the determining factor in the yielding capacity of the several varieties. In the comparison given below, the average yield of the spelt is compared with the average yield of ten varieties each of oats and barley, the periods of growth for which are practically equal to that of the spelt.

Average yield of spelt—980 pounds per acre.

Average yield of barley—844 pounds per acre.

Average yield of oats—1058 pounds per acre.

Of the three grains, oats gave a little the best yield and barley the poorest in the crop of 1900. As an average for three crops, 1898 to 1900 inclusive, the results are as follows:

Average yield of spelt—1,843 pounds per acre.

Average yield of barley—1,770 pounds per acre.

Average yield of oats—1,798 pounds per acre.

In the above comparison the average yield of the best producing varieties of barley and oats, according to the results obtained from a three year's trial, and the yields secured from the best producing spelt at the station are compared. It will be noticed that the spelt ranks first with an advantage of forty-five pounds over the oats while barley yields seventy-three pounds less than the spelt.

VARIETIES OF MILLET.

Thirteen varieties of millet were grown at this station in 1899. The seed was sown June 7th and 8th. The drill was set to sow three pecks of flax per acre. There is a marked difference in the size of the seed of the different varieties of millet so that the actual rate of seeding was not the same for each variety. The size of the seed is noted in Table XXIII together with the other results of the trial.

German millet No. 10 (southern grown seed) did not mature seed. Samples of seed of the other varieties were saved and planted June 5th, 1900 on fall plowed land, which had been cultivated and kept in good condition after it had become fit to work in the spring. A strain of Siberian millet (No. 20) and a new sample of southern grown German millet (No. 19) were also included in this trial.

Drouth injured the early maturing sorts, and especially those of the broom-corn type. The later kinds did well, having been favored by the rains.

German millet No. 19 was harvested September 11th—ninety-eight days after planting. It had made a heavy growth of leafy fodder, yielding over five tons of hay per acre, but it was only beginning to ripen seed when cut.

German millet No. 6 has been grown at this station since 1896. German millets Nos. 10 and 19 were samples of southern grown seed planted for the first time in North Dakota in the years noted. The millet from the southern grown seed, makes a heavy growth of fodder, but produces few heads and is not inclined to mature seeds in this latitude except during long seasons. A comparison of the crops for the two years, from the two kinds of seed gives the following:

Average yield per acre, North Dakota seed..	5349	2195
Average yield per acre, southern grown seed..	8450	105
Difference	3101	2090

TABLE XVIII.—VARIETIES OF MILLET.

Bulletin Number	Variety	Where from	Crop of 1899						Crop of 1900		Avg. 2 crops	
			Days maturing	Height of straw per acre	Yield of straw per acre	Kind of heads	Color of seed	Size of seed	Weight per bushel	Yield per acre	Straw per acre	Seed per acre
				in.	lb.				lb.	bu.	lb.	bu.
6	German	College Farm	82	37	6670	fox tail	light yel.	mod.	53 1/2	35.9	5,349	43.9
7	Early Fortune	Sioux Falls Seed Co.	80	28	5611	close br.	red	large	54 3/4	9.9	..	21.4
8	New Siberian	..	85	37	5644	fox tail	light red	med.	40	16.2	5,651	23.2
9	Common	Northrup, King & Co.	78	35	5621	..	light yel.	..	52	33.4	..	35.3
10	German (southern grown seed)	..	142	39	6621	..	didn't m.	at seed	..	..	..	..
11	Blk Voronezh broom-corn, U.S. 2795	Russia, by U. S. Dept. Agr.	79	36	4910	loose br.	glossy br.	large	58 1/2	34.2	..	35.3
12	Hog	Northrup, King & Co.	78	36	4814	close br.	light yel.	med.	57 1/2	30.6	..	30.3
13	Hungarian	..	85	33	6724	fox tail	light gr.	small	41 1/2	15.6	6,455	24.6
14	Earliest Russian	Salzer's Seed Co.	85	37	6568	..	..	..	39	11.9	6,372	21.4
15	Tambov broom-corn, U.S. No. 2794	Russia, by U. S. Dept. Agr.	71	40	3835	loose br.	red	large	51 1/2	47.0	2,650	30.9
16	Red Voronezh broom-corn, U.S. 2796	..	66	39	3134	broom	..	..	53 1/2	38.4	3,243	40.4
17	Red Russian broom-corn, U.S. 2797	" " " "	71	40	3948	loose br.	"	me. lge	56 1/2	45.8	2,920	28.9
18	Red Orenburg broom-corn, U.S. 2860	" " " "	71	37	4928	close br.	"	large	56 1/2	42.7	3,160	41.2
19	German, (southern grown seed)	Northrup, King & Co.	..	44	..	fox tail	light gr.	small	39	..	2,223	31.4
20	Siberian	..	88	40	..	"	yeish red	med.	46	..	10,279	4.1
											5,561	23.0
												*8,450

*Average of No. 10 and No. 19.

The North Dakota seed has given one and one-half tons less fodder, but over a ton more grain than the southern grown seed. It is observed that as millet becomes acclimated here it tends to mature earlier, and to produce more seed. The good condition for growth late in the season of 1900 favored the late maturing, southern grown millet seed and has made the average difference in hay yield for the two years greater than should be expected for the average season.

In order to compare the yields of grain for millet, oats and barley, the average yield of the three best producing varieties in each class for the years 1899 and 1900 are given below:

Average seed yields per acre.....	2092 lbs.
Millet	2092 lbs.
Oats	1780 lbs.
Barley	1763 lbs.

FLAX EXPERIMENTS.

The flax trial of varieties in 1899 was made upon fall plowed land, which had produced a crop of wheat in 1898. The flax was sown at the rate of three pecks per acre, on May 15th. The Riga fiber flax was in nearly full blossom June 30th and averaged twenty inches high, while the other varieties were only fourteen to fifteen inches high and had only a few blossoms.

In 1900 the trial was made on ground which grew wheat in 1899. The land was plowed in the spring and harrowed thoroughly, kept free from weeds and covered with a good soil mulch until seeded, May 16th. The flax came up at once making a good even stand. Table XVII gives the results of the trials.

TABLE XVII.—VARIETIES OF FLAX.

Bulletin No.	Variety	Where From	Crop of 1900					Crop of 1899		Average for 3 Crops, 1898, 1899 and 1900	
			Days Maturing	Length of Straw	Weight per Bushel	Seed per Acre	Straw per Acre	Seed	Straw	Seed	Straw
*5	Riga Fibre.....	J. C. Swan	77	24	Lb. 52½	Bu. 10.6	Lb. 1683	Bu. 14.1	Lb. 2383	Bu. 14.1	Lb. 2348
*6	Common	Fargo, North Dakota.....	90	18	53¾	11.2	1164	18.6	2500	16.5	2070
*7	Russian.....	Salzer's Seed Co.....	78	20	53½	16.0	1515	19.0	2235		
8	Odessa	Fleming	90	18	52¾	12.1	1322				

* In Bulletin No. 39, No. 5 was published as No. 306, No. 6 as No. 307 and No. 7 as No. 155.

The tabular statement shows a marked difference in the number of days required for maturing different varieties in the season of 1900. That difference is in part due to several days of wet weather which occurred between the days of cutting the early and late kinds. In 1899 Riga fiber flax ripened nine days and Russian flax two days earlier than the common sort obtained from local sources.

The Riga fiber flax produces a long straight straw with few branches. It yields less seed but more straw than the seed flax, and experts say that it yields more and a better quality of fiber for linen manufacture, than does common flax.

In the trial of 1899, the flax plots extended across a strip of ground which had been manured heavily in the fall of 1897. The ranker growth of the flax on this part of the plot was very noticeable throughout the season. It came up more quickly, branched stronger, blossomed earlier and more profusely, grew two to four inches higher and ripened two or three days earlier than the flax on the unmanured ground. The crop was estimated as one-eighth greater both in seed and straw on the manured ground.

FLAX AND WHEAT MIXED.

A three years' trial of sowing flax and wheat together has been made. In the trials in 1898 and 1899, the wheat and flax were sown at the same date and at the rate of one bushel of wheat and two pecks of flax per acre. Both grains were sown with a shoe drill, the wheat having been drilled first and the flax afterward, in parallel drill rows.

In practice it is the custom to cross drill the flax, but the small trial plots used in these experiments made that method impracticable.

In 1898 owing to an oversight the plot was not sown until May 31st, too late in the season to produce a good crop. In 1899 the seeding was done by May 15th. The flax ripened a few days earlier than the wheat in 1898 and at the same time as the wheat in 1899. The following tabular statements show the results obtained from two crops

Yield of wheat in 1898	11.1
Yield of wheat in 1899	18.9
Average for the two years.....	15.0
Yield of flax in 1898	3.8
Yield of flax in 1899	4.0
Average for the two years	3.9

In 1899 plots of the same variety of wheat adjacent to the one which grew flax and wheat and sowed at the same time, yielded twenty-two and five-tenths bushels per acre. A similar plot of flax of the same variety as that grown with the wheat yielded eighteen and six-tenths bushels per acre. Allowing 60 cents a bushel for the wheat and 90 cents for the flax gives the following:

Wheat alone	\$ 13.50
Flax alone	16.74
Average	\$ 15.12
Wheat and flax grown together....	14.94
Difference in favor of unmixed grain \$	.18

The wheat grown with the flax graded No. 2 northern, eighty per cent hard. It was badly bleached. That grown alone graded No. 2 northern, ninety-five per cent hard. Both were subject to the same weather conditions and were threshed on the same day. The flax grown alone weighed fifty-one and one-half pounds per bushel. That grown with wheat weighed fifty-three pounds per bushel, and was cleaner than that grown alone.

It is the common practice when the method of sowing wheat and flax together is followed to sow the flax a week or ten days later than the wheat—about the time wheat is coming up.

In order to secure data upon the relative time and quantity to sow of these grains when they are grown as a mixed crop, the following experiments were begun in 1900. This trial includes six different rates of seeding. The wheat was sown upon all of the plots on the same day. Two plots were seeded to flax as soon as the wheat was in, others were seeded ten days later, and two plots were seeded fifteen days after the wheat was sown. The plan of the experiment together with the data obtained is shown in Table XVIII.

FLAX AND WHEAT, CROP OF 1900.

TABLE XVIII.—SHOWING PLAN OF EXPERIMENTS AND RESULTS.

Plot No.	Crop	Date Sown	Rate per Acre Peck	Date Ripe	Stand	Height of Straw Inches	Yield per Acre Bushels	Weight per Bushel Pounds
1	Wheat.....	May 5....	4	Aug. 1...	$\frac{5}{8}$	26	13.65	60 $\frac{1}{2}$
	Flax.....	" 5....	2	" 2...	$\frac{3}{8}$	13	1.79	54 $\frac{1}{4}$
2	Wheat.....	May 5...	4	Aug. 4...	$\frac{3}{4}$	33	19.56	56 $\frac{1}{4}$
	Flax.....	" 16...	2	" 4...	$\frac{3}{8}$	18	1.64	50 $\frac{1}{4}$
3	Wheat.....	May 5....	3	Aug. 1...	$\frac{3}{8}$	25	9.28	60
	Flax.....	" 5....	2	" 2...	$\frac{1}{2}$	13	1.66	54 $\frac{1}{2}$
4	Wheat.....	May 5...	3	Aug. 3...	$\frac{3}{8}$	27	12.67	59
	Flax.....	" 16...	2	" 3...	$\frac{1}{2}$	13	1.60	55 $\frac{1}{4}$
5	Wheat.....	May 5...	3	Aug. 3...	$\frac{7}{8}$	29 $\frac{1}{2}$	15.53	57 $\frac{1}{2}$
	Flax.....	" 21...	2	" 5...	1-10	15 $\frac{1}{2}$	.31	
6	Wheat.....	May 5...	2	Aug. 3...	$\frac{1}{2}$	26	11.46	58 $\frac{1}{4}$
	Flax.....	" 16...	2	" 3...	$\frac{1}{4}$	14	1.23	54 $\frac{1}{2}$
7	Wheat.....	May 5...	2	Aug. 3...	$\frac{3}{4}$	29	15.82	57 $\frac{1}{2}$
	Flax.....	" 21...	2	" 5...	1-10	15	.37	
8	Wheat.....	May 5...	4	Aug. 3...	$\frac{3}{4}$	30	16.28	57
	Flax.....	" 16...	1	" 4...	1-25	14	.43	
9	Wheat.....	May 5...	3	Aug. 4...	$\frac{5}{8}$	30	15.70	57 $\frac{3}{4}$
	Flax.....	" 16...	1	" 4...	$\frac{3}{8}$	17	1.35	53 $\frac{3}{4}$
10	Wheat.....	May 5...	2	Aug. 3...	$\frac{1}{2}$	28	12.21	58 $\frac{1}{4}$
	Flax.....	" 16...	1	" 3...	$\frac{3}{8}$	14	1.10	53

The grain was harvested from all the plots on August 2nd. The wheat was all ripe enough to cut upon that date, but some of the flax was too green, as may be seen by referring to Table XVIII. In the column marked "stand" the figures given are judgments from observations at the time of harvest. In the case of flax the per cent of a stand was evidently placed too high, as is shown by the yield of seed obtained. The yields both of flax and wheat are based on the weight of the clean grain, as it was separated by the fanning mill. It will be noticed that the yield of flax is comparatively small from all of the plots.

Comparing the yields from the plots which were subjected to the different rates of seeding gives the following:

Plot Number	2		4		6		8		9		10	
Kind of Grain	Wheat	Flax	Wheat	Flax	Wheat	Flax	Wheat	Flax	Wheat	Flax	Wheat	Flax
Rate of seeding per acre.....	pk. 4	pk. 2	pk. 3	pk. 2	pk. 2	pk. 2	pk. 4	pk. 1	pk. 3	pk. 1	pk. 2	pk. 1
Yield per acre ...	bu. 19.56	bu. 1.64	bu. 12.67	bu. 1.60	bu. 11.46	bu. 1.23	bu. 16.28	bu. 0.43	bu. 15.70	bu. 1.35	bu. 12.21	bu. 1.10

Sowing four pecks of wheat and two pecks of flax per acre has given the largest yield both of wheat and flax in the above experiment. It should be observed, however, that this is the result of a single trial in a very dry season when grain stood poorly. In a favorable season thinner sowing would probably give more favorable results.

Comparing the average of the yields from plots 1 and 3 upon which the flax and wheat were sown at the same date with the average yield from plots 2 and 4 upon which the flax was sown ten days later than the wheat, the following results are noted:

Wheat and flax upon the same date	11.47	1.73
Flax sown ten days later than wheat	16.12	1.62
Difference in favor of sowing the flax ten days later than the wheat	4.65	0.11

Comparing the average yield from plots 2 and 6 with that from plots 5 and 7 gives the following results:

Flax sown ten days later than wheat	12.07	1.42
Flax sown fifteen days later than wheat	15.68	0.34
	+3.61	-1.08

Sowing the flax fifteen days later than the wheat has not injured the wheat crop but has given practically no flax at all.

These results seem upon the whole to favor sowing the flax a week or ten days later than the wheat. The cultivating which the wheat received caused a ranker growth and larger yield. In the above trial the wheat was two inches high ten days after it was sown and to prevent injury, the drill chains were not allowed to drag when the flax was sown. It might be better to sow the flax just before or as the wheat was coming up, when the chains could be allowed to drag, which would give the ground more cultivation and cover the flax seed better.

Flax and wheat grown together on very rich land made a better showing than they did on ordinary soil. The flax made a

rank growth and acted as a support for the wheat plants. It would seem, therefore, that upon very fertile soil where wheat is likely to grow rank and lodge that the two grains may be profitably grown together, but on ordinary land which is only fertile enough to produce one good crop of wheat or flax in a season, these trials indicate that nothing is gained by attempting to produce two crops on the same ground at the same time.

The writers wish to call attention to the fact that this trial has not extended through a very long time, and that the season of 1900 was a very unusual one, and that in consequence these indications should not be taken as final.

QUANTITY OF FLAX SEED PER ACRE.

Riga fiber flax was used in this experiment, the chief object being to learn the effect of thick and thin sowing of flax upon the yield and quality of the straw and fiber. The flax followed wheat each year and was sown on May 15th in 1899, and on May 16th in 1900. It was sown with a shoe drill, in drill rows six inches apart. In each trial the ground was fall plowed and was thoroughly harrowed and kept in good condition and free from weeds until the flax was sown. Table XIX gives some of the data obtained.

TABLE XIX.—FLAX FIBER—DIFFERENT QUANTITIES OF SEED PER ACRE.

Plot Number	Seed per Acre	Crop of 1899.					Crop of 1900		Average Two Crops		
		Stand	Days Maturing	Height of Straw	Weight per Bushel	Grain per Acre	Straw per Acre	Grain per Acre	Straw per Acre	Grain per Acre	Straw per Acre
	pks.			In.	Lb.	Bu.	Lb.	Bu.	Lb.	Bu.	Bu.
1	2	Good	79	31½	53½	14.2	2386	10.3	1697	12.3	2041
2	3	Good	79	30½	53	14.1	2393	10.6	1683	23.3	2038
3	4	Good	79	29½	53½	15.1	3272	10.7	1541	12.9	1957
4	5	Thick	79	29½	54½	15.0	2345	10.8	1600	12.9	1972
5	6	Thick	79	28½	54½	15.3	2289	10.8	1879	13.0	2084
6	7	Thick	79	28	54	14.8	2112				
7	8	Very thick	79	28	54	15.1	2441	12.5	1784	13.8	2113
8	10	Very thick	79	26½	53½	14.7	2220	11.8	1753	13.3	1987
9	12	Very thick	79	26	53½	12.0	2660	8.3	1680	10.1	2170

In the above trial there appears to be no regularly marked difference in the yield of either the seed or straw. The thin sown flax grew the heaviest and longest straw, but it had more branches and less of long straight straw than the thick sown flax.

TABLE XX.—SEED FLAX—DIFFERENT AMOUNTS OF SEED PER ACRE—CROP OF 1900.

Plot number	Seed per acre	Stand	Days maturing	Height of straw	Wheat per bushel	Quality of Seed	Grain	Straw
	pk.			in.	lb	per cent	bu.	lb
1	1	½	92	21	52¾	85	12.9	1623
2	2	4-5	90	16½	52¾	85	12.7	1283
3	3	9-10	90	16	52¾	82	10.3	1210
4	4	good	90	16	53	87	13.8	1362
5	5	thick	90	17	52¾	85	16.8	1743
6	6	"	91	17½	50¾	75	15.5	1345

In 1900 a trial was made in which Odessa flax No. 4 was sown at different thicknesses to learn the effect on the yield and quality of the seed. The ground used for this trial grew flax in 1899, was fall plowed and kept cultivated in the spring until the flax was seeded. Table XX gives the data obtained.

No conclusion can be drawn from this single trial. In the dry season of 1900 the thick seeding, viz: four to six pecks per acre, gave larger yields and a relatively greater profit than the thinner sowing. Two to three pecks per acre is our usual rate of seeding flax on the station farm.

VARIETIES OF BUCKWHEAT.

Six varieties of buckwheat were grown in the comparative trial in 1899. Five of these were tested in 1898. No. 6 was received from the U. S. department of agriculture, and came direct from Russia. All of the varieties were sown June 7th, with the shoe drill, set to sow five pecks of wheat per acre.

All of the varieties made a rank growth and blossomed freely all through the summer, but few of the blossoms fertilized and produced berries. The two Russian varieties seem to be best adapted to our conditions.

The scarcity of bees in this locality may be the cause of the poor fertilization of the blossoms.

Table XXI submitted herewith gives the data recorded.

TABLE XXI.—VARIETIES OF BUCKWHEAT, CROP OF 1899.

Bulletin Number	Variety	Where From	Days Maturing	Height of Straw	Berry		Weight per Bushed	Yield per Acre	Average Yield for 1898 and 1899
					Color	Size	Lb.	Bu.	Bu.
+1	Russia, U. S. No. 2.....	Russia, by U. S. Dept. of Agriculture..	69	31	Brown.....	Medium large...	43½	21.1	23.5
+2	Silver Hull.....	W. Atlee Burpee & Co.....	81	40	Silver Gray.....	Medium.....	46	11.2	15.2
+3	New Japanese.....	W. Atlee Burpee & Co.....	84	47	Brown.....	Medium large...	43¾	19.8	25.0
+4	Calcutta.....	Salzer Seed Co.....	81	46	Silver Gray.....	Medium small..	50½	18.9	20.9
+5	Common.....	Salzer Seed Co.....	84	46	Brown.....	Large.....	42½	17.2	18.2
6	Orenburg U. S. No. 2801.....	Russia, by U. S. Dept. of Agriculture..	70	33	Brown.....	Medium large...	45¾	30.0	

* 42 pounds per bushel.

† These varieties are published in Bulletin No. 39, under other numbers as follows: No. 1 as No. 101, No. 2 as No. 141, No. 3 as No. 142, No. 4 as No. 151, No. 5 as No. 153.

A Russian variety, No. 6 introduced by the U. S. department of agriculture gave the largest yield and is the most promising of any variety tried at this station.

Only two varieties of buckwheat were sown in 1900. Russian No. 1 and Orenberg No. 6. The ground used grew turnips in 1899, and was fall plowed. It was cultivated early in the spring and was clean and in good condition, when the buckwheat was sown, June 5th. The grain came up quickly, grew rapidly and blossomed freely. The crop was harvested August 30th, at which time there were many blossoms and only two-thirds of the kernels were mature; although some of the grain had become ripe and shelled out and fallen to the ground. The straw stood thirty inches high at harvest time. The yield of Orenberg was twenty-four bushels per acre. By reason of an accident the yield of the other variety was not obtained, but field inspection indicated that it was as good as Orenberg.

A TRIAL OF VARIETIES OF POTATOES.

Forty varieties of potatoes were grown in the trial in 1899. Twelve of these, Nos. 39 to 51 inclusive, were grown in 1898. The others were secured from the various seedsmen named in the column marked "Where From," being the kinds, generally, which were the most highly advertised. The seed was cut two to three eyes to the piece and planted by hand in furrows about four inches deep and three feet and four inches apart. The hills were two feet apart in the row. All the varieties were planted May 19th and 20th.

TABLE XXIV.—VARIETIES OF POTATOES.

Bulletin number	Variety	From Where	Stage of maturity at trost, Sept. 17	No. of hills harvested	Average size of tubers	Shape	Color	Depth of eyes	Fingers and toes	Mealiness	Flavor	Yield per acre	Marketable	Small	Seabby	Per cent frozen
439	Early Andes.....	H. C. Marsh.....	4 5 ripe	158	large	oval obli'g	rus't red	shallow	Per ct	Per ct	Per ct	Bu.	Per ct	Per ct	Per ct	1
440	Early Dawn.....	H. C. Marsh.....	3 4 ripe	154	med. large	long oval	russet	medium	10	85	90	204.5	76	5	27	6
441	Burpee's Extra Early.....	W. Atlee Burpee & Co.	nearly gr.	167	med. small	long oval	lgt russet	med. deep	10	85	90	201.9	62	5	10	6
442	True Early Rose.....	" " " "	"	155	medium	oval	red	medium	2	85	85	149.9	78	9	10	6
443	Carman No. 1.....	" " " "	"	161	med. large	oval	white	"	2	85	85	208.3	72	11	9	6
445	Early Beauty of Hebron.....	" " " "	% ripe	163	large	med. obli'g	rd. russet	med. deep	2	90	85	200.3	87	6	1	0
446	Burpee's Superior.....	" " " "	nearly gr.	164	"	long oval	white	medium	5	70	75	203.8	59	13	22	7
447	Rural New Yorker No. 2.....	" " " "	green	170	medium	oval	white	shallow	5	85	85	236.0	80	11	5	4
448	Six Weeks.....	J. A. Salzer Seed Co.....	4 5 ripe	156	large	long oval	russet	medium	3	80	75	182.7	68	7	19	6
449	Early Ohio.....	Exp. Station Farm.....	% ripe	160	med. large	oval obli'g	rd. russet	med. shallow	2	90	95	173.0	63	8	20	2
450	World's Fair.....	L. L. Olds.....	1-5 ripe	170	medium	oval	white	shallow	2	90	95	210.6	78	12	8	2
51	Joseph.....	Northrup, King & Co.....	unearly gr.	158	large	oblong flat	rd. russet	deep	5	95	90	167.7	92	7	1	6
52	Early Minn.....	" " " "	"	167	med. small	med. long	russet	medium	5	95	90	207.8	77	15	1	6
53	Early Fortune.....	" " " "	green	171	small	long oval	rd. russet	"	4	95	90	207.8	74	14	10	2
54	Pingree.....	" " " "	"	168	medium	long oval	light	med. shallow	4	75	80	204.3	86	9	3	2
55	Freeman.....	" " " "	very green	164	"	oval	white	medium	..	80	80	201.3	91	6	3	2
56	Triumph.....	" " " "	ripe	164	med. large	round	red	"	..	70	70	142.0	84	8	7	1
57	Montana Rose.....	" " " "	% ripe	169	"	long	rd. russet	med. deep	1	75	75	125.0	78	5	2	15
58	N. K. & Co's Ext. Early Oh.....	" " " "	3 4 ripe	170	"	obli'g oval	"	med. shallow	1	80	80	220.5	75	5	10	10
59	N. K. & Co's Ideal.....	" " " "	green	168	"	"	lgt russet	medium	1	85	80	202.7	90	6	4	5
60	Early Mayflower.....	" " " "	% ripe	169	"	"	lgt russet	shallow	3	80	80	205.3	64	8	23	5
61	American Wonder.....	Sioux Falls Seed Co.....	nearly gr.	159	med. small	long	lgt rus-et	medium	..	85	80	140.2	89	4	4	1
62	Wonderful Harvest King.....	Salzer Seed Co.....	green	164	med. large	oval flat	white	med. deep	..	65	75	149.1	94	2	3	1
63	Salzer's Earliest.....	" " " "	ripe	165	medium	round	red	medium	5	65	65	151.2	95	2	3	2
64	Sharff's Early Dakota.....	" " " "	3 4 ripe	125	med. small	long	lgt russet	"	..	70	70	151.2	82	6	50	12
65	Free Silver.....	" " " "	very green	161	med. large	oval	light	medium	5	65	65	151.2	82	6	3	2
66	Iron Clad.....	" " " "	nearly "	167	med. "	long	lgt russet	shallow	..	70	70	151.2	84	3	3	2
67	Secretary Wilson.....	" " " "	3 5 ripe	169	medium	long oval	white	med. deep	3	85	90	222.1	70	7	16	9
68	Algonia.....	" " " "	nearly gr.	169	"	long	"	med. shallow	5	85	75	185.6	82	8	8	1
69	Hundred Fold.....	" " " "	green	163	"	oval	"	shallow	..	75	80	183.7	90	9	3	1

	McKinley	Early Michigan	Senator	White Ohio	Thoroughbred	Abundance	Bliss Triumph	Early Market	Lakeside Champion	Snow Flake	Salzer Seed Co.	nearly gr.	medium	lg. & irreg.	white	medium	10	80	95	218.7	70	4	24
70	Early Michigan	..	..	..	..	..	..	..	..	..	Salzer Seed Co.	171	medium	lg. & irreg.	white	medium	..	80	80	218.7	70	4	24
71	Senator	..	..	..	..	..	..	..	..	..	L. L. May & Co.	165	"	oval	rd. russet	"	..	85	80	175.3	70	13	7
72	White Ohio	..	..	..	..	..	..	..	..	..	Farmer Seed Co.	164	"	long oval	lt. russet	"	..	85	75	195.9	58	7	30
73	Thoroughbred	..	..	..	..	..	..	..	..	..	"	168	"	med. lg. & fl.	rd. russet	med. deep	..	85	85	206.8	56	8	8
74	Abundance	..	..	..	..	..	..	..	..	..	"	171	"	round	white	shallow	1	65	65	243.6	67	10	18
75	Bliss Triumph	..	..	..	..	..	..	..	..	..	"	171	"	long oval	red	medium	3	90	85	184.2	89	7	4
76	Early Market	..	..	..	..	..	..	..	..	..	"	169	"	long oval	rd. russet	med. deep	..	75	60	144.1	89	8	2
77	Lakeside Champion	..	..	..	..	..	..	..	..	..	"	146	"	long oval	white	shallow	5	80	70	161.8	20	7	65
78	Snow Flake	..	..	..	..	..	..	..	..	..	"	148	"	oval	white	shallow	..	85	80	133.1	78	16	1
79		..	..	..	..	..	..	..	..	..	"	148	"	oval	white	shallow	..	85	85	164.9	67	15	3

The percentage of large potatoes may be found by subtracting the percentage of small potatoes from 100.

*60 pounds in a bushel.

†The following varieties were published under other numbers in Bulletin No. 39 as follows: No. 39 as No. 262, No. 40 as No. 263, No. 41 as No. 264, No. 42 as No. 265, No. 43 as No. 266, No. 45 as No. 268, No. 46 as No. 269, No. 47 as No. 270, No. 48 as No. 271, No. 49 as No. 272, No. 50 as No. 273.

Each plot consisted of one row four hundred and twenty-eight feet long. Fifteen pounds of potatoes were planted in each row, which made one and two pieces in a hill.

The spring was favorable. The potatoes came up well and made a good stand in almost every case. They were well cultivated and kept free from weeds, but were not cultivated deep and received no hilling.

Digging was begun September 30th and completed October 20th. On the night of September 27th all of the potatoes which were exposed at the surface of the ground were frozen. At digging the frozen ones were sorted out and weighed and the percentage of frozen potatoes determined as given in Table XXIV. The difference in the percentage of frozen potatoes between the several varieties indicates which kinds develop the most tubers near the surface. The hills in each row were counted at digging time—one hundred and seventy-one hills in a row is a perfect stand. The number of hills of each variety dug is noted in the table, but the yields are calculated in every case for a full row. The accompanying table gives a very complete description and record of the results of the trial.

Sixteen varieties out of the forty kinds grown in 1899 were planted in the field trial in 1900. The potatoes were planted May 18th on fall plowed ground, which had been cultivated and was in good condition.

The potatoes came up evenly and were well cultivated and cared for during the season. All varieties were injured by the protracted drouth of June and July and all were more or less attacked by root rot, which entirely destroyed some of the hills. The early varieties were fully ripe and most of the vines were dead at frost September 16th. The vines of the later sorts were in every case partly mature.

The description of each of the varieties named in Table XXV has been given in the record of the 1899 crop and will not be repeated here. (See Table XXIV.)

TABLE XXV.—VARIETIES OF POTATOES, CROP OF 1900.

Record No.	Variety	Yield per Acre Bushels	Mar- ket- able Per ct	Small Per ct	Scab- by Per ct	Stage of Maturity of Vines at Frost Sept. 16
*39	Early Andes.....	103.2	73	19	8	Ripe.
*40	Early Dawn.....	157.2	71	12	17	Ripe.
*43	Carman No. 1.....	103.0	80	20	0	$\frac{2}{3}$ ripe.
*46	Burpee's Superior....	99.7	63	29	8	$\frac{1}{3}$ ripe.
*47	Rural N. Yorker No. 2.	79.6	76	24	0	$\frac{1}{2}$ ripe.
*48	Six Weeks.....	150.5	74	8	18	Ripe.
*49	Early Ohio.....	140.0	59	14	27	Ripe.
*50	World's Fair.....	44.5	69	26	5	Mostly ripe.
54	Pingree.....	82.6	61	36	3	Green.
55	Freeman.....	108.1	87	13	0	$\frac{1}{3}$ ripe.
56	Triumph.....	97.2	73	27	0	Ripe.
59	Ideal.....	91.0	77	18	5	$\frac{1}{2}$ ripe.
67	Secretary Wilson....	86.0	72	22	6	Mostly ripe.
73	White Ohio.....	130.2	69	20	11	Ripe.
74	Thoroughbred.....	97.6	65	29	6	$\frac{2}{3}$ ripe.
75	Abundance.....	59.7	61	22	7	$\frac{2}{3}$ ripe.

*These varieties were published under other numbers in Bulletin No. 39, as follows: No. 39 as No. 262, No. 40 as No. 263, No. 43 as No. 266, No. 46 as No. 269, No. 47 as No. 270, No. 48 as No. 271, No. 49 as 272 and No. 50 as No. 273.

TABLE XXVI.—VARIETIES OF POTATOES GIVING HIGHEST YIELDS IN 1900.

Record No.	Variety	Yield per Acre Bushels	Harvest Season
40	Early Dawn.....	157.2	Early.
48	Six Weeks.....	150.5	Early.
49	Early Ohio.....	140.0	Early.
73	White Ohio.....	130.2	Early.
55	Freeman.....	108.1	Medium late
39	Early Andes.....	103.2	Early.
43	Carman No. 1.....	103.0	Medium late

TABLE XXVII.—GIVING VARIETIES OF POTATOES GIVING HIGHEST YIELDS AS AN AVERAGE FOR THREE CROPS, 1898, 1899 AND 1900.

Record No.	Variety	Yield per Acre	Harvest Season
		Bushels	
40	Early Dawn.....	168.5	Early.
46	Burpee's Superior.....	163.0	Medium late.
39	Early Andes.....	161.6	Early.
48	Six Weeks.....	154.6	Early.
49	Early Ohio.....	148.3	Early.
43	Carman No. 1.....	136.4	Medium late.
47	Rural New Yorker No. 2.....	130.2	Medium late.

TABLE XXVIII.—VARIETIES OF POTATOES GIVING HIGHEST YIELDS, AVERAGE OF TWO CROPS, 1899 AND 1900.

Record No.	Variety	Yield per Acre	Harvest Season
		Bushels	
40	Early Dawn.....	179.5	Early.
74	Thoroughbred.....	170.6	Medium.
73	White Ohio.....	168.5	Early.
46	Burpee's Superior.....	167.8	Medium late.
48	Six Weeks.....	166.6	Early.
49	Early Ohio.....	156.5	Early.
55	Freeman.....	154.8	Medium late.
67	Secretary Wilson.....	154.0	Medium early.
39	Early Andes.....	153.8	Early.
43	Carman No. 1.....	151.7	Medium late.

In this locality none except the early maturing varieties of potatoes can be depended upon for a crop each year. In other parts of the state the late sorts are successfully grown. Among the varieties tested at the station, World's Fair, Carman No. 1, Freeman and Rural New Yorker No. 2 may be mentioned as late kinds, which can be recommended for many good qualities. Other late varieties have outyielded these sorts, but are not so good in shape, size or quality.

Of early potatoes, the Early Ohio is still one of the best. The seed secured from Northrup, King & Co., produced a very good strain of this excellent potato. The Early Dawn and Early Andes are other good early varieties. These varieties are much like the Early Ohio. For the three year test, Early Dawn has been the largest yielder of any variety in the trial. The Early Beauty of Hebron is a good yielder, but not so good in shape and a little later than the Ohio and Andes.

THICKNESS OF PLANTING POTATOES.

This experiment was begun in 1898 and continued in 1899 but not in 1900. Early Ohio No. 49 was the variety used. The seed was cut from two to three eyes to the piece and planted by hand in furrows about four inches deep. The potatoes were planted May 20th and 22nd. One row 428 feet long constituted a plot. These potatoes received the same cultivation as the varieties. Table XXIX gives the results of the trial, also the average yield for 1898 and 1899.

The results for 1899 are more irregular, but upon the whole similar, to those obtained in 1898. There is a general decrease in yield as the distance between the hills is increased. Doubling the amount of seed planted in hill did not increase the yield but it increases the proportion of small and scabby potatoes.

Close planting not only gives the largest yields but the potatoes are more even in size and less rough and scabby than those planted far apart. This is true for early potatoes, but may not be true for late maturing varieties. The study of the root systems of potatoes has shown that the late sorts have a more extended root system than the early kind. Accordingly they need more root room and more soil to feed upon.

TABLE XXIX.—THICKNESS OF PLANTING POTATOES.

Plot No.	How planted	No. of pieces in a hill	No. of hills harvested	Yield per acre	Marketable	Small	Scabby	Frozen	Average yield per acre for two years—1898-1899
				bu	pr ct	pr ct	pr ct	pr ct	bu
1	3½ feet by 10 in....	1	420	226.1	83	5	7	5	216.6
2	3½ feet by 12 in....	1	389	218.5	83	7	5	5	200.1
3	3½ feet by 14 in....	1	347	219.7	83	6	6	5	193.2
4	3½ feet by 16 in....	1	308	190.0	54	8	29	9	175.4
5	3½ feet by 18 in....	1	253	117.5	84	5	9	2	137.2
6	3½ feet by 20 in....	1	253	147.1	83	7	4	6	140.6
7	3½ feet by 24 in....	1	197	206.3	76	7	9	8	161.8
8	3½ feet by 30 in....	1	160	189.5	76	9	9	6	155.4
9	3½ feet by 36 in....	1	141	161.6	57	13	24	6	128.2
10	3½ feet by 24 in....	2	181	157.4	51	10	29	10	134.3
11	3½ feet by 30 in....	2	179	180.9	60	13	19	8	145.7
12	3½ feet by 36 in....	2	114	193.2	53	11	26	10	95.3

DEPTH OF PLANTING POTATOES.

This experiment was discontinued in 1900. In 1899 Early Ohio potatoes were used in this trial and the seed was prepared as described in the thickness of seeding trial. The potatoes were planted by hand, one piece in a hill, in rows three and one-third feet apart. The hills were eighteen inches apart in the row. The planting was done May 22d. The soil was in much better condition than it was the year before. The potatoes all came up well, the deeper plantings giving a better stand than the shallow planted plots. In 1898 those planted more than six inches deep came up very poorly. Table XXX gives the results of the trial and also the average yields for two years.

DEPTH OF PLANTING POTATOES.

Plot No.	Depth planted	Stand	No. of hills harvested	Yield per Acre	Marketable	Small	Scabby	Frozen	Average yield for two yrs, 1898-1899
				bu	pr ct	pr ct	pr ct	pr ct	bu
1	3 inches.....	good	266	197.1	67	10	13	10	152.6
2	4 inches.....	good	255	199.2	76	9	9	6	159.5
3	5 inches.....	good	272	191.1	82	12	5	1	140.4
4	6 inches.....	good	256	188.0	78	10	8	4	148.2
5	7 inches.....	good	288	185.7	88	9	2	1	139.5
6	8 inches.....	good	280	180.3	87	8	5	0	134.6

The potatoes planted three to five inches deep gave the largest yields, but a poorer quality of tubers than those planted deeper. Those planted deep gave scarcely any loss from freezing and very little from scabiness and were the nicest and best selling potatoes produced.

Experiments conducted at this station show that shallow, flat cultivation gives larger yields of potatoes than deep cultivation and hilling. In light soils, as proven by trials in other states, shallow, level cultivation gives the best results. It would seem better, therefore, to plant potatoes fairly deep, five to six inches at least, and give them surface cultivation rather than to plant shallow and be obliged to hill in order to keep the tubers beneath the ground. The root study, referred to in the discussion of thickness of planting, shows that deep cultivation and hilling must injure the roots of the plants. Hilling also opens up the ground and exposes more surface for evaporation, thus unduly drying out the soil.

ROOT CROPS.

Plot of Mammoth Yellow Giant Mangels planted June 8, 1899, in drills two and one-half feet apart yielded at the rate of eight tons six hundred twenty-six pounds per acre. The seed was old and germinated poorly. The poor stand accounts for the small yield. In 1898, thirteen and one-half tons of these beets were grown on an acre. In 1900 a large crop of mangels was harvested, but the weight of the crop was accidentally lost.

Two varieties of rutabagas were grown in 1899. The seed was planted with the grain drill, in rows two and one-half feet apart. Later the plants were thinned to six inches apart. The crop was well cultivated and weeded.

Hurst's Monarch Swede from Northrup, King & Co. yielded seven tons, eighteen hundred sixteen pounds per acre. White Russian from Farmer Seed Co. gave a yield of seven tons, fourteen hundred and eight pounds per acre. More than one-half of the roots in each case were small and of little value.

In 1899, a small plot of five-hundredths of an acre of sugar beets planted with the Planet, Jr. seed drill, in rows twenty inches apart and thinned four to six inches in the row yielded at the rate of thirty-two tons of beets per acre. Beets grown here are not rich enough in sugar to be of value for manufacturing purposes, but they make an excellent feed for sheep and cattle.

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EXPERIMENTS WITH BEANS.

In 1898 two plots of common navy beans were planted on June 15th. Both were planted with a corn planter. On one plot the rows were forty-four inches apart or the full width of the planter; on the other the rows were twenty-two inches apart. Frost on the night of September 8th of that year found these beans still immature, although those planted closest were nearer ripe and produced some good beans.

In 1899 this trial was continued. Navy beans were planted in rows twenty-two, twenty-four and thirty-six inches apart. The first plot was planted with the corn planter. The beans were planted at about the same rate in the row, as described under varieties. The first plot named was not planted until June 12th, the others were planted June 8th. The following are the results obtained:

	Yield Per Acre
Beans drilled in rows two feet apart	15.7 bu
Beans drilled in rows three feet apart	12.2 bu
Beans planted with corn planter in rows twenty-two inches apart.....	14.2 bu

The close planting in drills has given the best results. There was not much difference in the quality of the beans, but those planted in rows two feet apart ripened several days earlier than those planted three feet apart.

VARIETIES OF BEANS.

In 1899 six varieties of beans advertised by northwestern seedmen were secured and planted in our trial plots. Each plot consisted of one row four hundred and twenty-eight feet long. The beans were planted on June 8th, with the grain drill, in rows three feet apart, by stopping up part of the feed holes. Small beans like the navy may be planted very well in this way but the larger kinds in this trial were split more or less in being forced through the feed holes of the drill. About one quart of beans was planted in a row. At this rate it would take one bushel to plant an acre. For the Dewey Navy and California Wonder varieties, the drill was set to sow three and one-half bushels of oats per acre. This rate planted the beans fairly thick and gave a good stand. The feed was opened wider for the larger beans.

All the varieties came up well and made a good stand. They were well cultivated and kept free from weeds. Each of the six kinds tested ripened and made good crops, although there is considerable difference in the degree of earliness, as will be

noticed from Table XXII. The beans were pulled by hand and stacked in the field, in small round piles which were pinned down with sharpened sticks to keep them from being blown about by the wind. When dry the beans were hauled in and threshed (in this case with the flail.)

In 1900 the trial was made in practically the same manner as described, but the beans were planted in rows two feet apart, and each plot consisted of four rows of each variety. The ground used had been in rape in 1899, and was fall plowed. The beans were planted June 5th. The season was very unfavorable. After being stunted in growth by the drouth, the heavy rains of August caused a renewed growth, so that the beans, especially the earlier maturing sorts, failed to ripen evenly and many shrunken and blackened beans were the result. The wet fall was also unfavorable to the proper curing of the crop. The piles were protected by pinning a cap of foxtail over each, to shed the rain, otherwise the whole crop would have been lost. As it was when the beans were hand picked, only about one-half to two-thirds of the total yield was a salable product.

It is very essential that the beans be not allowed to get wet while piled in the field. Rain causes loss by blackening and shelling, so that just as soon as possible after pulling, the crop should be placed under cover. September in North Dakota usually furnishes favorable weather to cure beans. The yields and other data obtained in these trials are given in Table XXII.

TABLE XXII.—VARIETIES OF BEANS.

Bulletin No.	Variety	Where From	† Days Maturing	Height of Vines	Length of Pods	Beans			Yield per Acre		Average two Crops
						Color	Size	Form	1899	1900	
1	Brown or Swedish..	Northrup-King Co.....	95	In. 12	In. 3	Dark....	Med. large	Oval.....	*Bu. 13.3	*Bu. 16.1	*Bu. 14.7
2	Aristook.....	"	83	7	4	White....	Medium ..	kid'y shp'd	7.6	5.8	6.7
3	California Wonder.	"	90	14	3	White....	Small....	Oval.....	13.3	8.4	10.8
4	Red Kidney.....	"	95	11	5	Light red	Large	kid'y shp'd	7.1	6.5	7.8
5	Dewey Navy	Oscar H. Will & Co.....	85	11	3	White....	Smallest..	Oval.....	10.7	11.9	11.3
6	Great Northern	"	82	7	4	White....	Medium ..	kid'y shp'd	9.0	6.4	7.2

* One bushel equals 60 lbs.

† The description is for the crop of 1899.

The two seasons during which this trial of varieties has been carried on have been longer than the average. In 1899 the beans were planted June 8th and the first killing frost occurred September 12th. In 1900 the planting was completed June 5th and there was no killing frost until September 17th.

As an average for the two crops the Brown or Swedish bean stands first, Dewey Navy second, and California Wonder third in yielding qualities. Of these three, the navy bean is to be preferred on account of its early season and good selling qualities. The Great Northern and Aristook beans are a little earlier, but are very dwarf and light yielding varieties, and are not to be compared in selling value with the navy.

A. M. TEN EYCK.

THE EFFECT OF AGE AND LENGTH OF SPROUTS UPON THE VITALITY OF SEEDS.

WHEAT, ONE YEAR OLD.

A trial was made with one-year old wheat to determine whether it is fit for seed when it is that old. This wheat had been kept in small muslin bags in a dry room and was apparently healthy. The ordinary laboratory seed tester was used in this trial, one hundred kernels of each of twelve varieties of hard wheat were placed in separate folds or pockets of the germinator. The different varieties varied in the percentage of germination from seventy-three to one hundred per cent, the average germination being ninety and one-half per cent. Seven of the varieties showing the lower percentages of germination were given a second trial, this time in sand, but the results differed very little from those obtained in the first trial. The results indicate that most "one-year old" wheat which has been kept in a dry place is fit for seed.

A sample of experiment station No. 66 wheat of the crop of 1899, which had been bottled up in glass display bottles for about sixteen months gave ninety-eight per cent of germination and also showed a high degree of vitality. The germination was rapid, being completed the third day after the seed was placed in the germinator.

WHEAT, TWO YEARS OLD.

A single sample of goose wheat was secured for this trial. The sample had been kept in a bag in a dry room since it was threshed. One hundred kernels were tried of which ninety-seven germinated.

WHEAT, FIVE YEARS OLD.

A single sample of five-year old wheat was available. It was of the western or Pacific slope soft wheat grown in northern Idaho in 1895. It had been kept in a tin box and in glass display bottles in a warm room during that time. One hundred seeds were placed in the germinator, all of which grew. Other experiments in the United States and Canada have reported that soft wheat germinates more readily than hard wheat, which indicates that it is hardly fair to compare it with the hard wheats.

Two samples of wheat taken from sheaves saved from the crop of 1895 were used for this trial. One sample was a fife wheat, while the other was a blue stem variety. One of the samples gave one hundred per cent of sprouted kernels, while the other produced ninety-eight per cent of sprouted kernels. Professor E. S. Goff in the seventh annual report of the Wisconsin experiment station says "seeds in general will retain their vitality longer in their natural covering, probably due to a more uniform degree of humidity." This fact may account for the good results which were secured in this trial.

SEVEN YEAR OLD MISCELLANEOUS SEEDS.

Buckwheat which had been kept in small muslin sacks since 1893 gave a germination of eighty-four per cent, which indicates that the vitality of the buckwheat is very good.

Mangel and clover seed did not germinate a single seed in two trials, one made in the germinator and one in a box of sand. Professor Lazenby of Ohio university, in Agricultural Science in 1895 says. "A vitality test of a series of seeds collected twelve years ago * * * of this series the seeds of clover, the common red and the white clover were the only ones that gave evidence of any vitality. Of the red clover twenty-six per cent germinated and of the white clover five per cent." Why the clover in our test did not germinate cannot be accounted for.

EIGHT YEAR OLD WHEAT.

This sample of wheat was gathered for display purposes and was used at the World's Fair in 1893. It has been kept in a glass case since that time for display and was shown in bundles. The vitality was very low in this sample, as is shown by the fact that only three per cent of it germinated. The seeds which sprouted, put out their germs upon the third and fourth days after being placed in the germinator.

In the seventh experiment station report of the United States copied from a German bulletin, which A. Bergerstein in a trial of testing seeds from one to ten years old the following is quoted: "Part of the specimens were taken from sheaves of grain and others as they came from the threshing machine. They were placed in paper pockets and kept in the laboratory. They were

tested at temperatures varying from nineteen to twenty-six degrees F. At the end of ten years, winter wheat germinated seventy-five per cent, rye two per cent, summer barley ninety-five per cent and oats ninety-three per cent. The following tabular statement shows the results:

SHOWING VITALITY AND VARIATION OF OLD SEED.

Variety of Wheat	No. of Test	Age of Seed	Date Started	Kernels Germinated				No. Tested
				3rd Day	4th Day	5th Day	Per Cent	
Minn. No. 51.....	1	1899	Oct. 29	96	1	..	97	100
Station No. 203.....								
Station No. 214.....	2	1899	29	86	4	2	92	100
Minn. No. 177.....	3	1899	29	70	18	5	93	100
Station No. 215.....								
Station No. 151.....	4	1899	29	61	14	5	80	100
Station No. 216.....	5	1899	29	68	12	9	89	100
Station No. 146.....	6	1899	29	45	18	14	77	100
Station No. 197.....	7	1899	29	98	1	..	99	100
Station No. 256.....	8	1899	29	94	3	1	98	100
Minn. No. 163.....	9	1899	29	53	10	10	73	100
Station No. 212.....								
Station No. 235.....	10	1899	29	69	16	3	88	100
Station No. 264.....	11	1899	29	97	1	1	99	100
Station No. 202.....	12	1899	29	99	1	..	100	100
Goose Wheat.....	13	1898	29	90	7	..	97	100
Station No. 182.....								
Buckwheat No. 3.....	15	1893	29	77	7	2	86	100
New Japanese.....								
Mangel	16	1893	29	..	..	..	....	100
Clover	17	1893	Nov. 21	..	..	..	....	100
World's Fair Wheat.....	14	1892	Dec. 13	1	2	..	3	100

A TRIAL WITH SPROUTED WHEAT.

To obtain fair samples of this year's wheat a small cupfull of the grain was dipped from the wheat as it came from the threshing machine. The kernels in the measure were counted, after which the sprouted seeds were separated from the sound ones and counted and the per cent of sprouted wheat calculated. One hundred kernels of the sound and one hundred kernels of the sprouted wheat were placed in the germinator. Sample No. 1 contained seven and one-half per cent of the sprouted wheat and ninety-seven and one-half per cent of the original mixed sample grew. Sample No. 2 containing thirty-one per cent of sprouted wheat gave ninety-two per cent of germination.

Sample No. 3, which contained forty-one and one-half per cent of sprouted kernels gave ninety-two per cent of germination.

Four samples of wheat were taken from bins as they had come from the threshing machine in the fall, and were placed in the germinator. They had been standing out in most of the rain during the fall, and some of the bundles had been reshocked. A very small per cent of it was sprouted.

Sample No. 4 contained thirteen and one-tenth per cent of sprouted kernels and in the original wheat ninety-seven per cent of the sound kernels, and eighty-seven per cent of the sprouted kernels germinated, making a total of ninety-four and seven-tenths per cent germination for the original sample of wheat.

Sample No. 5 contained twelve and one-tenth per cent of sprouted kernels in the original wheat; ninety-nine per cent of the sound, and eighty-six per cent of the sprouted wheat germinated, making a total of ninety-eight and three-tenths per cent of the original machine sample of wheat germinated.

Sample No. 6 contained six and six-tenths per cent of sprouted kernels, ninety-six per cent of the sound kernels, and sixty-eight per cent of the sprouted one germinated, making a total germination of ninety-three per cent of the original, or machine sample of sprouted wheat.

Sample No. 7 contained seven and nine-tenths per cent of sprouted kernels; ninety-nine per cent of the sound kernels germinated and seventy-three per cent of the sprouted kernels germinated, making a total of ninety-six and eight-tenths per cent of the original wheat germinated.

The length of the sprouts which the bin sample had reached could not be determined, as the threshing and general handling had broken them off.

In this trial the number of sprouted kernels in the seed ranged from six to thirteen, and the four samples averaged ten. The average percentage which sprouted was ninety-seven and seven-

rents. Sprouted seed is always weakened and therefore poorer than sound seed would be, but the above results indicate that a good crop could be secured with it, and seeding five per cent heavier would give the normal number of plants per acre. The following table gives the results:

VARIATION IN GERMINATION AND VITALITY IN THE 1900
CROP OF WHEAT.

Variety of Wheat	No. of Test	Age of Seed	Date Started	Kernels Germinated						Per Cent	No. Tested
				2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day		
Minn. 163..... Station No. 225...	1	1900	Nov. 5	87	13	..	..	..	..	100	100
Station No. 223...	1	1900	5	..	..	69	..	..	..	69	100
Screenings.....	2	1900	5	96	2	..	..	..	..	98	100
Screenings.....	2	1900	5	..	..	81	..	..	..	81	100
Tailings.....	3	1900	5	95	5	..	..	..	..	100	100
Tailings.....	3	1900	5	..	..	80	..	..	..	80	100
Haynes' Blue St'm No. 15, sound...	4	1900	Dec. 6	77	15	2	1	1	1	97	100
Haynes' Blue St'm No. 15, sprouted.	4	1900	6	58	20	5	..	..	..	83	100
Haynes' Blue St'm No. 14, sound...	5	1900	7	85	12	2	..	..	..	99	100
Haynes' Blue St'm No. 14, sprouted.	5	1900	7	14	9	3	..	..	..	86	100
Minn. No. 163, sound.....	6	1900	8	96	2	1	..	..	..	96	100
Minn. No. 163, sprouted.....	6	1900	8	62	6	..	..	..	..	68	100
Minn. No. 163, sound.....	7	1900	8	95	4	..	..	..	..	99	100
Minn. No. 163, sprouted.....	7	1900	8	66	6	1	..	..	..	73	100

A trial was made to determine what length of sprouts wheat may have and regerminate. Wheat of the Minnesota No. 163 variety from which the sprouted kernels were carefully removed by hand picking, was used in this trial. Two hundred kernels were placed in each of eight pockets in the germinator, and as soon as sprouts were visible on the kernels in the first pocket, they were taken out and thoroughly dried. The next day the seeds were taken from the second pocket, the day following the seeds from the third pocket were taken out and dried, and so on until the pockets were emptied. This plan make the last sprouts seven days older than the first ones. The radicles (root sprouts) and plumules (stem sprouts) were measured upon the different dates when the seeds were placed in the germinator for the second trial. After being dried for eight and one-half days they were again placed in the germinator to see what per cent of them would grow. The following table shows the variation in the period of growth, and what per cent germinated:

VITALITY OF SPROUTED WHEAT AND VARIATION IN ITS
MEAN PERIOD OF GERMINATION.

Variety of Wheat	No. of Test	Age of Seed	Date Started	Kernels Germinated						Per Cent	No. Tested	Length In.	
				2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day			Plu- mule	Radi- cle
Minn. No. 163, Stat'n No. 212.	1	1900	Nov. 21	39	20	8	8	..	..	75	100	5-16	¾
Minn. No. 163, Stat'n No. 212.	2	1900	22	31	18	21	5	..	..	75	100	¾	1¼
Minn. No. 163, Stat'n No. 212.	3	1900	23	10	36	7	1	..	..	54	100	2	2½
Minn. No. 163, Stat'n No. 212.	4	1900	20	53	12	10	3	2	1	81	100	⅛	½
Minn. No. 163, Stat'n No. 212.	5	1900	19	67	17	3	3	1	..	91	100	Just Sprouted	
Minn. No. 163, Stat'n No. 212.	6	1900	24	41	13	4	3	..	..	61	100	2¾	3½
Minn. No. 163, Stat'n No. 212.	7	1900	25	33	8	16	1	..	..	58	100	3½	4½
Minn. No. 163, Stat'n No. 212.	8	1900	26	20	25	..	..	..	..	45	100	3½	5

The second sprouting in pockets numbers 5 and 4, with sprouts one and two days old gave ninety-one and eighty-one per cent respectively. The sprouts on these seeds were healthy, but the sprouts on the kernels in the pockets containing the older sprouts were weak and sickly. The sprouts (stems) upon sample No. 4 were one-eighth inch long, when the sample was placed in the germinator the second time. It was readily noticed that the sickliness and weakness of growth increased with the age and consequent length of sprout. The oldest sprouts (stems) reached a length of three and one-half inches. The weights of the one hundred kernels constituting the samples in each of the pockets were taken after the first germination. The weights decreased gradually with the increase in age and consequent lengthening of the stem. The sprouts were broken off and not included in the weights recorded.

This trial indicates that sprouted wheat will regerminate and form healthy sprouts until the stem (plumule) has reached a length of three-fourths of an inch in the first germination and an average of eighty per cent of all sprouted wheat with the length of the stem not exceeding one-half an inch will again germinate.

STOCK AND BIN BURNED WHEAT.

In bulletin No. 9 of this station Professor Bolley writes: "Any seeds which have at any time been heated because of moisture when in bulk, are very liable to have been injured beyond ability to grow."

A trial made by the writers with one hundred and fifty kernels of stack burned wheat gave sixty-four and seven-tenths per cent of germination. This wheat could not have been burned very much, or the germ in the seed would have been killed, but nevertheless it would not be safe to use it for seed.

A trial was also made with a sample of bin burned wheat. Five hundred kernels were placed in the germinator. The sprouts were healthy but showed a somewhat longer period of germination, and gave an average germination of sixty-two and four-tenths per cent. This would not be safe to use for seed. Neither the stack burned nor the bin burned wheat could have burned very much, judging from the large germination that took place.

FROZEN WHEAT.

Superintendent S. A. Bedford of Manitoba in his report for 1890 writes: "Although the loss upon slightly frozen grain was small, the No. 3 or badly frozen wheat gave considerably less (yield) than No. 1 hard wheat and in unfavorable seasons no doubt would be greater.

No. 1 hard wheat sowed on breaking yielded thirty-three bushels per acre, while No. 3, badly frozen yielded twenty-nine bushels. On fallow No. 1 hard yielded twenty-four and one-half, and No. 1 frozen yielded twenty-three and one-half bushels per acre."

Professor Greene of the Minnesota station in bulletin No. 6 reports that results from six trials show a range of germination of from fifty-two to eighty-five per cent and in most cases produced vigorous, thrifty sprouts. Samples weighing forty pounds per bushel and less showed low germinating powers.

A trial of frosted grain by Professor Keffer of the South Dakota station is reported to have given percentages of germination ranging from fifty-four to eighty-two.

The above reports would certainly indicate that frosted and frozen wheat may be fit for seed and that a germination trial is the only sure way to determine its value.

CORN ONE YEAR OLD.

A variety known as Pre-historic corn which has been bottled up since the spring of 1899 germinated very slowly when placed in the germinator, requiring eight days for completion of the process. The same seed showed ordinary vitality nearly two years before when it was planted on the station ground. Only sixty-three per cent of it grew, which shows that it was not fit for seed.

Corn samples No. 14, 15 and 16 had been kept in small muslin sacks, in a dry room since 1899. They contained a few shrunken kernels, as if the corn had been husked somewhat green.

These varieties of corn were also slow in starting to germinate, requiring four days to complete its germination, the three varieties germinated ninety, ninety and eighty-four per cent respectively, or an average of eighty-eight per cent.

The sprouts on this corn were healthy, and it undoubtedly would be fit for seed if an allowance of ten per cent was made for the lack of vitality in some of the kernels. The lack of vitality may have been due in part to the corn not having been fully matured.

CORN SIX YEARS OLD.

A sample of Minnesota King corn from the crop of 1894 was given a germination trial. The corn remained upon the cob until shelled for use in this experiment. The mean period of germination was as high as that for the 1899 corn, requiring seven days to complete its germination, at the end of which time, seventy-seven per cent of it had sprouted.

VITALITY AND VARIATION IN THE TIME OF GERMINATION
OF CORN.

Variety of Corn	No. of Test	Age of Seed	Date Started	Kernels Germinated					Per Cent	No. Tested
				3rd Day	4th Day	5th Day	6th Day	7th Day		
Minnesota King.....	1	1900	Nov. 29	15	76	7	..	..	98	100
Minnesota King.....	2	1900	29	2	47	39	9	1	98	100
Pre-historic Corn.....	3	1899	29	11	26	19	2	5	63	100
Station No. 589.....	4	1899	Oct. 29	27	15	35	13	..	90	100
Station No. 190.....	5	1899	29	60	4	25	1	..	90	100
Station No. 555.....	6	1899	29	25	20	22	17	..	84	100
Minnesota King.....	7	1894	Nov. 29	3	25	23	16	10	77	100

ONE YEAR OLD OATS.

Three samples of our 1899 crop of oats was placed in the germinator to see what per cent of it would grow and if it would be safe to use oats of that age for seed. These samples had been kept in small muslin bags in a dry room, and consequently in the best possible condition. The vitality was good. Samples No. 1, 2 and 3 germinating one hundred, ninety-six and ninety-nine per cent respectively. Sample No. 1 completed its germination the third day, No. 2 in five days, and No. 3 four days after being placed in the germinator.

This trial indicates that old oats, i. e. which has been carried over one season under good condition is comparatively safe to use for seed.

EIGHT YEAR OLD OATS.

Samples No. 4 and 5 are from the crop of 1892 and were collected for exhibition at the World's Fair in 1893. They have been kept in exhibition cases in the bundle or sheaf since that time.

Number 5 is a variety of wild oats and was used with the cultivated varieties to compare its vitality. It has been standing in its natural covering in the straw since then, and undoubtedly this has helped it to retain its vitality. The germination for the two samples were eighty-seven and seventy-three per cent respectively.

ONE YEAR OLD BARLEY AND SPELT.

Two samples of barley from our 1899 crop were tested. They had been placed in small muslin bags and kept in a dry room. By reference to the table it will be noticed that the vitality of No. 2 was not as good as that of No. 1. The writers can find no cause for this unless it was due to the maturity of the barley, the one sample appearing to have been slightly more mature than the other. The germination of the two samples gave ninety-eight and eighty-eight per cent respectively.

The spelt was kept in the same condition as the barley and germinated ninety-eight per cent. In all three samples it will be noticed, the mean period of germination was very short, only one seed germinating after the third day.

VITALITY AND VARIATION IN GERMINATION OF OATS.

Variety of Oats	No. of Test	Age of Seed	Date Started	Kernels Germinated						Per Cent	No. Tested
				2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day		
Oats.....	1	1899	Nov. 30	63	37	..	..	..	..	100	100
Lincoln (62).....	2	1899	Dec. 1	76	16	1	2	1	..	96	100
Station No. 46.....	3	1899	1	89	9	1	..	..	..	99	100
Oats.....	4	1892	Nov. 21	..	59	24	2	2	..	87	100
Wild Oats.....	5	1892	21	..	7	39	9	3	15	73	100

VITALITY AND VARIATION IN GERMINATION OF BARLEY AND SPELT

Variety of Seed	No. of Test	Age of Seed	Date Started	Kernels Germinated			Per Cent	No. Tested
				2nd Day	3rd Day	4th Day		
Barley.....	1	1899	Nov. 30	57	42	..	99	100
Barley, Station No. 30.....	2	1899	Dec. 1	76	12	..	88	100
Spelt.....	3	1899	Nov. 30	58	39	1	98	100

FLAX FROM THE CROP OF 1900.

The samples of flax which have been available this year have been injured more or less by rain during the fall, which has made a large percentage of black and shriveled kernels. The seeds were counted and separated as described for wheat, and the per cent of shriveled and black kernels counted. One hundred kernels of each kind were placed in the germinator.

VITALITY AND VARIATION IN GERMINATION OF FLAX.

Variety of Flax	No. of Test	Age of Seed	Date Started	Kernels Germinated						Per Cent	No. Tested
				2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day		
Flax, sound.....	1	1900	Nov. 6	..	96	..	..	..	..	96	100
Flax, shriveled.....	1	1900	6	..	74	..	..	..	..	74	100
Flax, sound.....	2	1900	6	..	87	..	..	..	..	87	100
Flax, shriveled.....	2	1900	6	..	49	..	..	..	..	49	100
Flax, sound	3	1900	10	93	2	..	..	..	..	95	100
Flax, shriveled.....	3	1900	10	81	6	..	..	..	..	87	100
Flax, sound.....	4	1900	10	53	8	2	.	..	..	63	100
Flax, shriveled.....	4	1900	10	19	7	..	..	..	..	26	100
Flax, ice	5	1900	10	..	31	14	2	1	1	49	100
Flax, sound.....	6	1900	Dec. 13	8	8	1	1	..	..	9	200
Flax, shriveled.....	6	1900	13	1	..	..	..	..	..	½	200
Flax, sound.....	7	1899	Nov. 19	94	2	..	..	..	..	96	100
Flax, sound.....	8	1899	30	48	14	6	1	..	.	69	100
Flax, sound (2nd trial)	8	1899	Dec. 14	50	12	6	2	..	..	70	100

From the tabular statement it will be seen that flax sample No. 1 originally contained nineteen and seven-tenths per cent

of black kernels, that ninety-six per cent of the sound and seventy-four per cent of the black and shriveled seeds germinated, making a total of ninety-four per cent of the original flax seed which had germinated.

Sample No. 2 contained twenty-five and one-tenth per cent of black and shriveled seeds, eighty-seven per cent of the sound and forty-nine per cent of the black and shriveled kernels germinated, making a total of seventy-four per cent of germination in the original sample.

Sample No. 3 had forty and six-tenths per cent of black and shriveled kernels. In this sample ninety-five per cent of the sound and eighty-seven per cent of the black kernels germinated, making a total of ninety-four per cent of the original flax that germinated.

Sample No. 4 contained forty-seven and two tenths per cent of black and shriveled kernels. In this sample sixty-three per cent of the sound and twenty-six per cent of the black kernels germinated, making a total of the original flax that germinated forty-two per cent.

Sample No. 5 had been lying out in the rain and snow until November 17th. It had been frozen and contained as large a bulk of ice as of seed, when it came from the separator on the date named. The sample was dried and found to contain twenty-seven and four-tenths per cent of water. Of this sample of flax forty-nine per cent germinated.

Sample No. 6 was flax that had been lying out in the rain. It had been threshed while wet and placed in a bin where it had heated. Of this sample seventy-three and eight-tenths per cent was black and shriveled. Two hundred kernels of the sound seed and an equal number of the black and shriveled ones were placed in the germinator, only nine per cent of the sound and one-half per cent of the black kernels germinated, or a total of only two and seven-tenths per cent of the original flax seed. This low vitality is attributed to the bin burning.

ONE YEAR OLD FLAX.

Sample No. 7 was of the 1899 crop. It was all bright flax and germinated very quickly. The vitality was also very strong as ninety-six per cent of it germinated.

Sample No. 8 was also from the 1899 crop but neither the vitality nor the mean period of germination was as good as for No. 7, as only sixty-nine per cent of it germinated. This flax was again tried in the germinator and gave seventy per cent of germination or an average of sixty-nine and one-half per cent for the two trials. The sample of flax was examined very closely, but we could find no reason why it would not grow.

It seems to the writers that the only safe method of determining what amount of any particular sample of seed will grow is to try it in a seed germinator, where the time required to sprout and the strength and vigor of the growth of the seed can be seen. Mere sprouting if the growth is weak does not mean that a strong plant will result. It must be a matter of judgment and the person making the trial can get the best basis for judging by trying a sample of grain which is known to be good seed.

A good seed germinator can be made as follows: Invert a pie plate in an ordinary dinner plate and place a small amount of water in the dinner plate; place a cotton flannel cloth, wide enough to fold double from side to side over the inverted plate and long enough that the ends of the cloth will reach into the water in the largest plate. The cloth will carry the water up after the manner of a lamp wick, and seeds placed between the folds of the cloth will be kept moist enough to sprout. By lifting the upper fold of the cloth the seed can be examined at any time without doing them any harm. A second dinner plate of the same size as the first or larger one, should be placed over it, the rim resting upon the rim of the lower one. This upper plate simply prevents the rapid evaporation of the water. The above plan was illustrated by A. J. Pieters, in the United States Department of Agriculture Year Book of 1895.

J. H. SHEPPERD,
E. G. SCHOLLANDER.

ACKNOWLEDGMENTS.

During the past season A. M. Ten Eyck, M. S., has assisted me in conducting the experiment work undertaken by this department. The greater portion of the work has been carried jointly, while he has taken the entire responsibility for some pieces of work as will be seen by this report and by other publications.

Mr. H. M. Ash has acted as farm foreman during the past season and has aided the writer by becoming responsible for much of the detail work falling upon the department.

Mr. E. G. Schollander, an agricultural student in the college has given this department creditable assistance during the past six months.

This report contains a description of the results obtained by trial in which he became largely responsible for the details of the work.

J. H. SHEPPERD.

HORTICULTURAL DEPARTMENT.

To J. H. Worst, Director:

The work in this department has been modified somewhat during the past year, chiefly as regards fertilizer tests and work with vegetables.

The report for 1899 gives a brief outline and summary of the field work with different fertilizers upon the various garden vegetables and the last bi-ennial report gives the results of the experiments made under glass along the same lines.

The work under glass is being continued at the present time with celery, cabbage and tomatoes. The objects to be attained in these experiments are first to determine the exact proportion of each fertilizer required to give the maximum growth, and second to determine the kind of fertilizer best adapted to the different plants under trial. The fertilizers used are of five different kinds, all animal manures.

The field work with garden crops for the past season was along somewhat general lines, the object being to make the work illustrative and educational rather than distinctly experimental. This plan was adopted partly on account of the arrangements that had been made to bring a number of large farmers' excursions to the station, and also to lessen the expense of weighing and testing necessary when purely experimental lines of work are followed out.

The cultivation of vegetables in North Dakota in average years is attended with such little difficulty that there is no present demand for very elaborate or extensive experiments along that line. To develop new varieties of plants not fully successful in the state like the sweet corn, tomato and melons has been a part of the work of the department.

The line of work that does require experimentation is that of tree and fruit culture. Most of the inquiries coming to the department are from persons wishing to start a grove and set out a few bushes and small fruits about the garden. With the settlement of the newer portions of the state by those coming, for the most part, from regions where trees and fruits are common the first inquiry is as to what steps to take to give the new home some of the adornments and comforts of the old. Information

on these subjects must be furnished largely from our own experience and so far as possible the department is devoting itself to the cultivation of such trees, shrubs, fruits and general ornamental plants as are likely to succeed in the state.

With the limited funds at our disposal it has not been possible to carry on the cultivation of these to such an extent as the demands upon the department would otherwise warrant.

Aside from the original cost of stock, the labor of caring for a plantation of fifteen or twenty acres of trees has been quite out of the question. Such a feature properly managed could not fail to be a very valuable one, as it would afford opportunity to try the promising species of this and other countries and to determine what combination of species would give the best results after a given number of years. Enough money is wasted every year in nearly every county of the state by injudicious planting and improper management to more than maintain an arboretum ample for the needs of the institution. One correspondent writes that in his region alone over two hundred miles of hedge costing over \$35,000 had been sold to the farmers and after all that great expense it was the general opinion among them that the hedge would prove a failure. Whether it succeeds or not the price is much too great to pay for a single experiment.

During the past season several additional varieties of plums and small fruits have been added to the station gardens and the leading varieties are now fairly well represented. With the constantly increasing sales of nursery stuff in the state by firms and salesmen not familiar with our local conditions, it will be well to make tests of nearly everything likely to be offered for sale as a possible protection to patrons, whether the articles promise much value to the discriminating buyer or not.

In those parts of the state where active measures had been taken in 1899 for the suppression of the Rocky Mountain locust, it did not appear in any numbers in 1900, but in the region of Willow City, where no previous work has been done there was a hatching out of this pest in numbers that might have caused alarm in ordinary years. The practical destruction of the grain crop by drouth in early summer and the continued rains during the balance of the season were discouragements quite too great for anything like a normal increase of this pest. It remains to be seen just how numerous they will be next season.

The two most conspicuous insect pests of the season were the canker worm that defoliated so many trees in the early summer and the box elder bug that appeared in such numbers in the fall. Inquiries concerning both of these pests were very numerous. The canker worm feeds upon almost any kind of tree foliage, generally avoiding the willows and poplars when other food is to be had and on the other hand showing a special fondness for

the box elders. The destruction is wrought by the larva of a moth. The female lays her eggs upon the tree in the fall or early spring and these hatch out into small green "measuring worms" that eventually grow to about an inch in length. As the females are wingless they may be prevented from ascending the trees by some mechanical contrivance, such as bands of wool or tin collars sloping downward. These applied in early fall will prevent ravages the following season. If this precaution has not been taken, the proper remedy is to spray the trees with a solution of paris green, at the rate of one pound to 150 gallons of water. This should be done as soon as the worms are discovered and repeated once or twice at intervals of a few days. If the operation is delayed till the worms are fully grown but little good will result. Unless some disease or other restricting influence appears, great damage may be expected from this pest next season.

The box elder bug feeds by sucking the juice of the trees, so the evidences of its ravages are not so alarming as those of the canker worm. Moreover it appears much later in the season when the possibilities of injury are not so great. It appears first as a small pale reddish bug without wings, but as the season advances and it passes through the different stages it takes on dark wings banded with red. It is then something over half an inch long and about half as wide at the base of the wings from whence it tapers gradually toward the rear. Late in the fall it congregates in masses upon the body of the trees or upon buildings where it may be killed by hot water. Since it feeds by sucking it cannot be poisoned, but it may be destroyed by spraying the trees with one part kerosene mixed with sixteen parts of strong soap suds.

Aside from the additional equipment of an arboretum already mentioned, the department should be supplied with more space under glass for starting or forcing plants and also with grafting and storage cellars where manual operations may be carried on by classes in the winter time, and where half hardy ornamental plants may be stored during cold weather.

Respectfully submitted,

C. B. WALDRON.

STATEMENT.

GOVERNMENT AGRICULTURAL EXPERIMENT STATION, NORTH DAKOTA.

FEDERAL APPROPRIATION.

Statement of receipts and expenditures from July 1, 1899 to July 1, 1900.

RECEIPTS.

Received from U. S. Hatch act, March 2, 1887 \$ 15,000.00

DISBURSEMENTS.

Salaries	\$ 6,218.14
Labor	* 5,232.12
Publications	969.20
Postage and stationery	110.11
Freight and express	33.24
Heat, light and water	299.55
Chemical supplies	74.83
Seeds, plants and sundry supplies	287.97
Feeding stuffs	237.60
Tools, implements and machinery ..	328.59
Scientific apparatus	91.85
Live stock	100.40
Traveling expenses	155.40
Contingent expenses	76.00
Building and repairs	750.00
Fertilizers	35.00

\$ 15,000.00

R. A. SHATTUCK,
Secretary.

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